Responses to Comments

on the

Alternative Diesel Fuel Regulation



Released September 21, 2015

to be considered at the

September 24, 2015 Board Hearing

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I. SUMMARY OF COMMENTS AND AGENCY RESPONSE

Written comments were received during the 45-day comment period in response to the February 19, 2015 public hearing notice, written and oral comments were presented at the February 19 Board Hearing, and written comments were received during the 15-day notice dated May 22, 2015. Comments are identified by number on the comment letter or transcript containing the comment. When ARB changed the proposed regulation in response to a commenter's objection or recommendation, ARB's written response specifically notes the change and reason for it. In other cases, ARB's response sets forth the reasons ARB either disagrees with the comment or otherwise does not believe that the comment warrants a change to the proposal.

Comment Code	Comment Period Received
OP	Comments received during the 45-day comment period of the original proposal, Jan. 2 – Feb. 18, 2015
B	Comments received in written materials during the board hearing , Feb 19, 2015
T	Comments received as testimony at the board hearing, Feb 19, 2015
F	Comments received during the 15-day comment period May 22-June 8, 2015
SB	Comments received in written materials during the second board hearing, September 24 & 25, 2015
ST	Comments received as testimony at the second board hearing on September 24 & 25, 2015

The comment letters were coded by the order and the comment period in which they were received, and also tagged ADF, and the name of the organization or individual commenting. For instance, below, 01-OP-ADF-TEMA2013 is the first comment letter received during the 45-day comment period, and is an ADF comment sent by TEMA.

Several comment letters were directed at both the LCFS rulemaking and the Alternative Diesel Fuel (ADF) rulemaking. The comments directed at the ADF rulemaking are responded to below. The comments directed at the LCFS rulemaking are responded to in the LCFS Final Statement of Reasons.

Comment Letter Code	Commenter	Affiliation
1-OP-ADF-TEMA2013	Gault, Roger	Truck and Engine Manufacturers Assoc.

Comment Letter Code	Commenter	Affiliation
2-OP-ADF- Bosch	Johnson, Norman	Bosch
3-OP-ADF-WSPA2013	Reheis-Boyd, Catherine	Western States Petroleum Assoc.
4-OP-ADF-Oberson2013	Syz, Brittany	Oberon Fuels
5-OP-ADF-POET2013	Guarrici, Brian	POET
6-OP-ADF-Growth2013	Buis, Tom	Growth Energy
7-OP-ADF-CRE	Simpson, Harry	Crimson Renewable Energy
8-OP-ADF-NBB	Neal, Shelby	National Biodiesel Board
9-OP-ADF-AAM	Ughetta, Valerie	Auto Alliance Manufacturers
10-OP-ADF-TEMA	Gault, Roger	Truck and Engine Manufacturers Assoc.
11-OP-ADF-IWP	Wright, Curtis	Imperial Western Products
12-OP-ADF-CBA	DuBose, Celia	California Biodiesel Alliance
13-OP-ADF-WSPA	Reheis-Boyd, Cathy	Western States Petroleum Assoc.
14-OP-ADF-NLB	Case, Jennifer	New Leaf Biofuels
15-OP-ADF-Oberon	Boudreaux, Rebecca	Oberon Fuels
16-OP-ADF-POET	Willter, Joshua	Sierra Research for Poet
17-OP-ADF-GE 46-OP-LCFS-GE	Willter, Joshua	Sierra Research for Growth Energy
18-OP-ADF-GE	Willter, Joshua	Sierra Research for Growth Energy
19-OP-ADF-GE	Willter, Joshua	Sierra Research for Growth Energy
20-OP-ADF-GE	Willter, Joshua	Sierra Research for Growth Energy
21-OP-ADF-GE	Willter, Joshua	Sierra Research for Growth Energy
22-OP-ADF-GE	Willter, Joshua	Sierra Research for Growth Energy

Comment Letter Code	Commenter	Affiliation
23-OP-ADF-ALAC	Barrett, Will	American Lung Assoc., Calif.
24-OP-ADF-NOUS	Delahoussaye, Dayne	Neste Oil
1-B-ADF-NSB	Noyes, Graham	North Star Biofuel
2-B-ADF-Gershen	Gershen, Joe	Individual
3-B-ADF-GE 12-B-LCFS-GE	Willter, Joshua	Sierra Research for Growth Energy
1-T-ADF-SCAQMD	Miyasato, Matt	South Coast AQMD
2-T-ADF-NLB	Case, Jennifer	New Leaf Biofuel
3-T-ADF-CBA	DuBose, Celia	California Biofuel Alliance
4-T-ADF-NBB	Neal, Shelby	National Biodiesel Board
5-T-ADF-BSB	Teall, Russell	Biodico Sustainable Biorefineries
6-T-ADF-Gershen	Gershen, Joe	Individual
7-T-ADF-CF	Mortenson, Lisa	Community Fuels
8-T-ADF-CRE	Simpson, Harry	Crimson Renewable Energy
9-T-ADF-ALAC	Barrett, Will	American Lung Assoc.,Calif.
10-T-ADF-CCA	McGavern, Bill	Coalition for Clean Air
11-T-ADF-Neste	Delahoussaye, Dayne	Neste Oil
12-T-ADF-REG	Hedderich, Scott	Renewable Energy Group
13-T-ADF-NRDC	Mui, Simon	NRDC
14-T-ADF-DTF	Fulks	Diesel Technology Forum
1_F_ADF_WSPA	Reheis-Boyd, Cathy	Western States Petroleum Assoc.
2_F_ADF_NBB	Neal, Shelby	National Biodiesel Board
3_F_ADF_CBA	DuBose, Celia	California Biodiesel Alliance
4_F_ADF_TEMA	Gault, Roger	Truck and Engine Manufacturers Assoc.

Comment Letter Code	Commenter	Affiliation
5_F_ADF_POET	Willter, Joshua	Sierra Research for POET

A. COMMENTS PRESENTED PRIOR TO THE FEBRUARY 19, 2015 HEARING

Twenty-four comment letters were received during the 45-day comment period.[1] Each comment letter is reproduced below with responses following. Comment letter 17_OP_ADF_GE is 308 pages long and is reproduced in discrete sections with the responses following each section, for readability.

[1] Six of these letters were submitted in 2013, commenting on an earlier version of the ADF proposal that ARB withdrew from consideration in March 2014. In its notice withdrawing the 2013 proposal (see http://www.arb.ca.gov/regact/2013/adf2013/NDNPadf2013.pdf), ARB said that for the convenience of interested parties, it would include comment letters submitted on the 2013 proposal in the rulemaking record for its subsequent ADF proposal. In responding to comments contained in these 2013 letters, ARB provides substantive responses to comments that are relevant to the current rulemaking and otherwise notes when a comment is not relevant to the current proposal.

Comment letter code: 1-OP-ADF-TEMA2013

Commenter: Roger Gault

Affiliation: Truck and Engine Manufacturers Assoc.

The following letter was submitted to the ADF Docket during the 45-day comment period.

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1_OP_ADF
_Tema2013

STATE OF CALIFORNIA
AIR RESOURCES BOARD

Proposed Regulation on the	**)**	
Commercialization of New Alternative	**)**	~~**Agenda Item: 13-11-2**~~
Diesel Fuels	**)**	
	)	**Board Hearing:**
	)	~~**December 12, 2013**~~

COMMENTS OF THE TRUCK and ENGINE MANUFACTURERS ASSOCIATION

Roger Gault
Truck and Engine Manufacturers Association
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Chicago, Illinois 60606
(312) 929-1974

STATE OF CALIFORNIA
AIR RESOURCES BOARD

Proposed Regulation on the Commercialization of New Alternative Diesel Fuels	)	~~**Agenda Item: 13-11-2**~~
	)	**Board Hearing:**
	)	~~**December 12, 2013**~~

COMMENTS OF THE
TRUCK and ENGINE MANUFACTURERS ASSOCIATION

On October 22, 2013, the California Air Resources Board ("ARB") published a "Notice of Public Hearing to Consider the Proposed Regulation on the Commercialization of New Alternative Diesel Fuels" [CCR, Title 13, Chapter 5, Article 3, Sub article 2, Section 2293] ("the Proposal").

The Truck and Engine Manufacturers Association ("EMA") is the international trade association that represents the interests of the world's leading manufacturers of engines, including manufacturers of compression ignition engines used in both on-highway and nonroad products that will utilize the fuels covered by the Proposal.

I. Background

EMA has actively participated in the development of the testing program and regulatory development process that has led to the Proposal concerning the use of biodiesel blends, renewable diesel fuels, and gas-to-liquid (GTL) fuels. EMA has been an active participant in discussions with ARB staff and at industry workshops.

At the outset of the rulemaking process, and throughout the testing program, EMA and its members emphasized to ARB the importance of ensuring that any alternative fuel regulations recognize the fundamental importance of fuels to the performance, durability, and exhaust emission levels of both new and existing products. In short, fuels cannot exist independent of the engines that use them any more than engines can exist without the fuels required to power them.

The test program undertaken by ARB associated with the evaluation of biodiesel blendstocks from various feedstocks, renewable diesel fuels, and GTL fuels is by far the most comprehensive study of the effects of fuel properties on exhaust emissions ever conducted. Even so, the test program evaluated only a relatively small segment of the broad population of engines, vehicles/equipment, and emission control systems that make up the diverse inventory in California with only a small sub-set of alternative diesel fuels.

While the Proposal includes several features important to evaluating whether an alternative fuel is appropriate for use in the marketplace, it also raises a significant number of concerns associated with effective implementation of the prescribed regulatory program. **ADF 1-1**

II. Impact of the Proposal

Although the Proposal would not directly regulate the activities of engine manufacturers, several aspects of its implementation could require engine manufacturer participation. For example, for a new alternative fuel to move from Stage 2 to either Stage 3A or 3B, the fuel supplier must "obtain approval of at least 75% of compression ignition engine original equipment manufacturers for which the ADF is expected or intended to be used." That implies that engine manufacturers must have had sufficient opportunity to evaluate the proposed new fuel, or fuel blending component, to assess acceptability in both new and existing engines in the California marketplace. The Proposal does not set forth a process for determining how to meet the 75% threshold or whether it has been met. Engine manufacturers are in favor of having the regulation call for their acceptance of new fuels, but are concerned that the lack of an ARB approval process may result in this important requirement being difficult or impossible to enforce. Therefore, EMA recommends that the Proposal be revised to require written acceptance of a new alternative diesel fuel meeting the required consensus standard by engine manufacturers representing 75% by number and 75% by engines in service for those manufacturers certifying engines with ARB for sale in California. ADF 1-2

Even if the Proposal were revised to clarify the level of engine manufacturer acceptance required, EMA still has significant concerns regarding misfueling by the 25% of manufacturers and/or engines that have not accepted the use of the alternative fuel. In addition, engine manufacturers are concerned that the use of alternative fuels will impact engines' ability to demonstrate compliance with in-use emission requirements and on-board diagnostic requirements given the potential disparity in fuel properties between alternative fuels and California petroleum diesel fuel. The lack of any long-term emission influence evaluation of alternative fuels, either during the rulemaking development or as a requirement of the Proposal, raises significant concerns.

Given the 5-year maximum total timeframe outlined for Stage 2, it is not reasonable to assume that engine manufacturers will have sufficient time to complete the evaluations necessary after they have determined that a new fuel is viable. Similarly, it is not realistic for a new fuel to "achieve adoption of all consensus standards applicable to the ADF" within the prescribed timeframe. A review of the timeline associated with development of the ASTM D6751 standard for biodiesel and its inclusion at up to the B5 level in D975 would be beneficial as a guideline for the time necessary to complete the required consensus standards and engine manufacturer approvals. It also may be instructive to note that ARB's October 2011 report on biodiesel, renewable diesel, and GTL fuels was five years in the making. Both of those examples demonstrate that the requirements for completion of Stage 2 will require more time than currently proposed. Engine manufacturers also are concerned that the requirement for completion of Stage 2 to develop a "consensus standard" for the alternative fuel may be misconstrued to mean a narrow consensus among fuel providers rather than the necessary broader consensus among engine manufacturers, users, and regulators in addition to fuel providers. ADF 1-3

By the Proposal declaring that B6-B20 blends are at Stage 3A, ARB apparently deems conventional biodiesel methyl ester meeting D6751 and blended at B6-B20 levels as having met Stage 2 requirements. While a number of engine manufacturers have approved B20 for use in some of their engines, it is not clear that the 75% approval threshold, however defined, has been achieved. As noted above, there are substantial questions concerning how ARB intended the 75% approval threshold to be achieved. The apparent ARB approval of B20 blends raises significant

questions concerning both how this determination was made, and what regulatory action ARB intends to undertake to prevent misfueling using B20 blends in engines that have not been accepted for B20 use by the engine manufacturer. ADF 1-3 cont.

In addition, it appears that ARB has determined that conventional biodiesel methyl esters meeting D6751 can be blended at levels greater than B20 without meeting the following Stage 2 requirements: (i) achieve adoption of a consensus standard applicable to the ADF; (ii) obtain approval of at least 75% of compression-ignition-engine original equipment manufacturers; (iii) identify appropriate fuel specifications for the ADF; and (iv) identify appropriate mitigation strategies for the ADF, none of which have been achieved. Additionally, the apparent approval of biodiesel blends greater than B20 conflicts with ARB's stated purpose in the Proposal to "foster the introduction and use of innovative ADFs in California that have no significant adverse impacts overall on public health or the environment relative to conventional, petroleum-based CARB diesel." ARB's own testing program confirmed previous testing that demonstrated a significant increase in NOx emissions from compression-ignition engines when utilizing biodiesel blends greater than B20. Additionally, ARB's NOx mitigation test program (utilized to identify options for NOx mitigation for biodiesel blends less than B20) identified no known means to mitigate NOx emissions from blends greater than B20. That error is particularly egregious given that ARB is implementing a low-NOx emission program for heavy-duty engines concurrent with this rulemaking which requires significant NOx reductions. ADF 1-4

ARB also has deemed all renewable diesel fuels, gas-to-liquid fuels, and Fisher-Tropsch fuels as "Drop-in Fuel" by definition — meaning that those fuels can be utilized without further study by ARB, engine manufacturers, or California consumers. Without definition of the fuels and/or their fuel properties, engine manufacturers have significant concerns associated with untested, unacceptable fuels being placed in the California marketplace. ARB does propose properties for what is termed "Low-NOx Diesel base fuel" in Appendix A(a)(2), but has not proposed any requirement that the prescribed properties be utilized to define the minimum requirements for the renewable diesel fuels, gas-to-liquid fuels, and Fisher-Tropsch fuels deemed drop-in fuels. Recent experience has demonstrated that this loophole may be utilized by fuel producers that desire to market sub-standard products, reap sales benefits, and disappear when problems are identified. In addition, engine manufacturers do not have sufficient experience with fuels meeting ARB's Low-NOx Diesel base fuel to accept their use without constraint. While market factors may be expected to preclude significant use of those fuels neat, or at very high (greater than 75%) blend levels, neither ARB nor engine manufacturers have conducted any testing to demonstrate that such fuels could be used without significant engine performance, or regulatory compliance concerns. Engine manufacturers recommend that the definition of "Drop-in Fuel" be revised to remove renewable diesel, gas-to-liquid, and similar fuels and revise the definition of "Diesel Substitute" to clarify that: "'Diesel Substitute' includes, but is not limited to, blends of no more than 75% renewable diesel, gas-to-liquid fuels, Fischer-Tropsch fuels; …" ADF 1-5

ARB has proposed the use of a minimum of 5.0 percent Di-tert-butyl peroxide (DTBP) in biodiesel blendstock, subsequently blended to 20.0 percent or less, as one option for an acceptable biodiesel NOx mitigation measure (reference Appendix A(a)(1)). Engine manufacturers have significant concerns associated with this option for NOx mitigation. Specifically, peroxides such as DTBP are known to reduce oxidation stability of fuels. Neither ARB nor the fuels industry has demonstrated that the proposed final B20 blend would comply with the ASTM D7467 requirement for oxidation stability, or that use of sufficient anti-oxidant additive to meet the D7467 ADF 1-6

requirements would result in a final fuel that either mitigates NOx emission increases or is viable for engines in the marketplace. The fuel industry has advised that it would not recommend the use of this option to mitigate NOx emissions from biodiesel blends. ARB's inclusion of such an option effectively proclaims it a viable fuel option. As prescribed in Proposal Section 2293.3(b), a total of all additives should not exceed 1.0 percent by volume unless required for NOx mitigation. Engine manufacturers support the ARB determination that cumulative additive rates of greater than 1.0 percent by volume are unacceptable, but do not agree with its proposed exemption for the mitigation of NOx. ADF 1-6 cont.

III. Recommendations

ARB should make several changes to the Proposal prior to its adoption as a Final Rule.

Specifically, EMA recommends that ARB:

1. Prescribe that the Stage 2 time period be a minimum of 2 years, with the opportunity to renew every 2 years for a total of 10 years.
2. Establish, in writing, a process that ARB will utilize to determine that 75% of engine manufacturers have accepted a Stage 2 fuel.
3. Define the term "consensus standard" for purposes of the Final Rule to include, at a minimum, consensus among fuel producers, fuel marketers, engine manufacturers, and users.

ADF 1-2 cont.

4. Direct the California Division of Weights and Measures to develop and implement regulations that mitigate the potential for misfueling as part of the transition from Stage 2 to Stage 3A or 3B, including, among other things, regulations associated with the use of B6-B20 blends deemed by ARB to be in Stage 3A that have not been accepted for use in all engines in California.

ADF 1-3 cont.

5. Clarify that all biodiesel blends greater than B20 are Stage 1 fuels that must meet all of the Stage 1 and Stage 2 program requirements prior to determination if Stage 3A or 3B is appropriate for those fuels.

ADF 1-4 cont.

6. Include a table of minimum fuel properties associated with "Drop-In Fuels" as defined by the Final Rule.
7. Revise the definition of "Drop-in Fuels" and "Diesel Substitute" to prevent blends of greater than 75% renewable diesel, gas-to-liquid fuels, Fischer-Tropsch fuels from being used prior to acceptance by engine manufacturers.

ADF 1-5 cont.

8. Delete the option to utilize a 5.0 percent DTBP additive treatment in B100 biodiesel blended into a finished B20 blend as a NOx mitigation measure.

ADF 1-6 cont.

If you have any questions about EMA's comments, or would like to discuss this matter further, please do not hesitate to contact us.

Respectfully submitted,

Engine Manufacturers Association

1_OP_ADF_TEMA2013 Responses

1. Comment: **ADF 1-1**
The comment questions whether the ADF proposal can be effectively implemented.

Agency Response:
ARB staff believes the ADF proposal can be effectively implemented. Responses **ADF 1-2** through **ADF 1-6** address the commenters' specific concerns in detail.

2. Comment: **ADF 1-2**
The comment questions how to meet the 75 percent threshold described in section 2293.5(b)(6)(A)3.

Agency Response:
The 75 Percent threshold refers to a requirement in Stage Two of the Phase-in Requirements for a new alternative diesel fuel (ADF). The ADF applicant must obtain approval of at least 75 percent of compression ignition engine manufacturers for which the ADF is expected or intended to be used. The approval must cover the ADF blend levels expected or intended to be used in those engines.

Each alternative diesel fuel can be used in a variety of engines from different manufacturers and in a variety of operations. Therefore, rather than trying to establish a one-size-fits-all approach, such as written acceptance of new ADFs by engine manufacturers, ARB staff believes that analysis on a case by case basis of the engine manufacturers' acceptance of each ADF is more appropriate. To provide more flexibility to the process, staff will work with engine manufacturers as ADFs are going through the Stage 2 requirements in order to ensure the level of review is sufficient. Therefore, there is no need for a more detailed approach on how to meet the 75 percent threshold as the exact method will depend on the nature and circumstances of the individual fuel being tested.

3. Comment: **ADF 1-3**
The comment questions whether misfueling may occur, and claims that the use of ADFs may impact an engine's ability to comply with in-use emissions requirements. Additionally the comment states that the lack of long-term emissions testing of alternative diesel fuels raises concerns. The comment questions the details on how to meet the 75 percent threshold whether or not biodiesel met the 75 percent threshold, described in section 2293.5(b)(6)(A)3, to move from Stage 2 to Stage 3, and questions the Stage 2 timeframe, as well as the definition for consensus standards. Additionally, the comment goes on to question whether the Stage 2 timeframe is sufficiently long.

Agency Response:
1. In section 2293.5(a), Stage 1 application, the applicant is required to provide the manner in which the distribution pumps will be labeled to ensure proper use of the fuel. This labeling standard must also be applied for Stage 2 and 3 fuels. In addition, all fuel dispensing pumps must be labeled in accordance with California Business and Professions Code, section 13480(a). This provision requires each component of the fuel storage and delivery system, including fuel pumps, to be affixed with an easily visible sign or label containing the name of the product. In the operation manual provided with each vehicle, the vehicle manufacturer must identify what fuel is acceptable and appropriate for use in that vehicle. Adequate fuel labeling and the vehicle manual information should minimize misfueling.

2. The testing completed as part of the ADF regulation development compared the effects of biodiesel and CARB diesel (among other fuels) in the same engine. The engines used for testing varied in age from several years old to several decades old. There was no significant effect based on model year other than the effects of new technology diesel engines (NTDEs) that use selective catalytic reduction (SCR). Therefore, ARB staff expects any possible emissions differences from biodiesel used in engines of different age have been captured. Emissions testing would be conducted, as appropriate, under the three phase process for new ADFs.

Further, the impacts of long-term use of an alternative diesel fuel in engines is considered by ARB's testing program during the development of consensus standards, a necessary pre-requisite under this regulation before commercialization of an ADF.

3. Please refer to response **ADF 1-2**, for an explanation of the 75 percent threshold**.** Biodiesel was an existing product in the market rather than being introduced as a new product so the circumstances are unique. Based on original equipment manufacturer (OEM) statements, more than 85 percent of engine manufacturers honor

warranties on a portion of their engines for biodiesel blends up to B20[2]. The willingness of engine manufacturers to replace engines using biodiesel blends up to B20 is evidence of their approval of its use within their engines. This 85 percent approval is sufficient to account for the 75 percent requirement threshold. Future fuels may face different methods of approval due to fuel variations, engine types, stage of development, and other factors.

4. The five year timeframe to complete Stage 2 is extendable in case of delays in multimedia evaluation, consensus standard development, or other good causes. Regarding extensions, the proposed ADF regulation section 2293.5(b)(4)(C) states that "the Executive Officer may provide additional extensions due to delays in completion of a multimedia evaluation, adoption of the applicable consensus standards, or for other good cause." In the event an ADF manufacturer requires more time, the Executive Officer can implement an extension that should eliminate the concern that the fuel application will fail merely because the manufacturers need more time than the 5 years normally allowed to evaluate the fuel. There is no maximum limit on these extensions, as long as the manufacturer has sufficiently good cause for the need. Staff believes this allows sufficient flexibility while providing enough time for the manufacturer to complete the requirements of Stage 2 and does not need adjustment.

5. Regarding consensus standards, California Business and Professions Code sections 13440 and 13450 require that the California Department of Food and Agriculture must adopt by reference the latest standards established by a recognized consensus organization or standards writing organization such as the ASTM International or SAE International. Once the standard is adopted, a fuel must conform to that standard to be sold commercially. Diesel fuel standards are generally developed by ASTM International and as such it is likely that providers of new ADFs will work with ASTM to develop standards in response to this requirement. Fuel marketers, producers, users, and engine manufacturers generally participate in the ASTM consensus process.

6. The commenter's concern regarding in-use requirements is not a concern in newer NTDE engines, but in fact, a hypothetical concern for older engines. Biodiesel is currently used in California and even more extensively in other parts of the country and staff has not seen any indication of these concerns. The compliance testing, if done in-use, is conducted using a specified certification fuel. As OBD systems are

[2] http://www.biodiesel.org/using-biodiesel/oem-information/oem-statement-summary-chart

further developed and regulations are implemented, we will work with manufacturers to ensure smooth implementation.

4. Comment: **ADF 1-4**
The comment questions ARB's determination that conventional biodiesel methyl esters meeting ASTM specification D6751 can be blended at levels greater than B20 without meeting specified Stage 2 requirements.

Agency Response:
The comment pertains to the 2013 proposal. The currently proposed regulation accommodates biodiesel blends up to 20 percent through in-use requirements. Blends of biodiesel above B20 must go through the phase-in requirements prior to commercial approval.

Regarding the B10 maximum and exceptions (B20): Under section 2293.6(a)(2) Pollutant Control Level, biodiesel blends are only allowed up to the B10 level. The exceptions to this B10 maximum limit are to obtain an exemption pursuant to section 2293.6(a)(5) or to use in-use control options, such as the additive DTBP, with biodiesel blends up to B20. The B20 blend level is the maximum allowed limit and no higher blends are permitted for use under this regulation. Biodiesel blends above B20 are not considered commercial fuels at this time, as they do not have consensus standards. In addition, because ARB staff did not find an effective mitigation option above the B20 level, biodiesel blends above B20 would not currently pass the requirements of Stage 2 using the mitigation options explored by ARB's testing. However, the regulation provides procedures for ADF manufacturers to certify biodiesel blends above B20 with different mitigation approaches from those investigated by ARB staff.

5. Comment: **ADF 1-5**
The commenter has concerns with renewable diesel (RD) fuels, gas-to-liquid fuels, and Fisher-Tropsch fuels being defined as "Drop-in Fuels" and requests that they not be allowed at levels above 75 percent blend levels

Agency Response:
ARB staff modified regulation as part of the 15-day changes, to remove the term *Diesel Substitute* and replace it by 'fuels.'

In addition, the fuels (renewable diesel, etc.) described would meet the definition of California diesel and are not regulated under the ADF proposal. There is an industry consensus standard for diesel fuels, ASTM D975. To the extent these neat fuels meet ASTM D975, they could feasibly be used at any blend level in diesel engines. For information on consensus standards, please see comment **ADF1-**

2Regarding the second issue, renewable diesel fuels, gas-to-liquid fuels, and Fischer-Tropsch fuels, and any other compression ignition fuels that are liquid hydrocarbons would meet the definition of California diesel and are therefore not regulated under the ADF proposal. There is an industry consensus standard for diesel fuels, ASTM D975. To the extent these fuels meet ASTM D975, they could be used at any blend level in diesel engines. For more information on consensus standards, see comment **ADF 1-3**.

6. Comment: **ADF 1-6**
The comment states concerns with the use of DTBP as an option for NOx mitigation. The concerns include not having demonstrated: (1) compliance with the ASTM oxidation stability standard and (2) that the use of anti-oxidant additive to meet those requirements would result in a fuel that decreases NOx and is viable in engines.

Agency Response:
Two additives 0 DTBP, and 2-ethylehexyl nitrate (2-EHN) - were tested and further evaluated as part of the biodiesel multimedia evaluation. These two additives were selected because they are the most common cetane improvers in the market. Based on the results of the studies, DTBP was found to be the only additive to effectively mitigate the NOx impact from the candidate biodiesel fuel for B6-B20. Therefore, DTBP was the only additive included as a mitigation option under the proposed regulation.

Although DTBP was included in the regulation for use as a mitigation method, the additive is not currently U.S. EPA certified for use at the maximum level needed to achieve mitigation in the ADF proposal (one percent needed at B20; 0.25 percent is certified). Prior to allowing use of DTBP above 0.25 percent, the additive would need to undergo further analysis by U.S. EPA and potential additive manufacturers. This federal restriction will limit the use of DTBP to lower levels until the U.S. EPA's analysis can be completed and U.S. EPA certifies the additive for use at higher levels. The analysis will inform U.S. EPA's determination of DTBP's reliability as a fuel additive blend at higher levels than the current certification.

In regards to the concerns about oxidation stability and viability in engines, the California Department of Food and Agriculture enforces ASTM fuel quality standards which include flash point requirements. Additionally, finished fuels, which could include additives, are subject to the ASTM standard, which includes an oxidation stability specification at the blend levels in which DTBP will be used.

Comment letter code: 2-OP-ADF- Bosch2013

Commenter: Norman Johnson

Affiliation: Bosch

The following letter was submitted to the ADF Docket during the 45-day comment period.

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2_OP_ADF
_Bosch2013

December 10, 2013

SUBMITTED ELECTRONICALLY

Clerk of the Board
Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: ARB's Proposed Regulation on the Commercialization of New Alternative Diesel Fuels

Dear Sir or Madam:

Robert Bosch LLC (Bosch), a U.S.-based subsidiary of Robert Bosch GmbH, is pleased to submit these comments on the Air Resources Board's (ARB) proposed regulation on the commercialization of new alternative diesel fuels (hereinafter, the proposed ADF regulation).

One of the largest global automotive original equipment suppliers, Bosch develops, manufactures, and supplies precision components and systems for motor vehicle manufacturers and other entities in the automotive industry. The light-, medium-, and heavy-duty vehicle solutions and technologies offered by the Bosch Diesel Systems division include fuel injection systems, exhaust-gas treatment, glow systems, and other systems and components. As the world leader in the development of cleaner, more fuel efficient diesel engine systems and components, Bosch has a strong interest in the proposed ADF regulation.

The following comments focus on Appendix 1 of the proposed ADF regulation, and more specifically on the di-tert-butyl peroxide (DTBP) mitigation option contained in section (a)(1)(A) of Appendix 1.



DTBP Needs Further Investigation Before ARB Establishes It as a NOx Mitigation Option for Biodiesel Blends

Notwithstanding the ARB staff's view that it is "unlikely . . . that higher biodiesel blends [will be] used in legacy, heavy-duty diesel vehicles"[1] and the staff's conclusion "that mitigation is highly unlikely to be needed,"[2] Bosch believes, particularly given the high volumetric composition of DTBP that would be required for B10 to B20 blends to be deemed NOx mitigated under the additive mitigation option (i.e., ≥0.75 percent DTBP in blends of B10 to < B15, and ≥1.0 percent DTBP in blends of B15 to B20), that thorough consideration needs to be given to the potential impact of DTBP on low- and high-pressure fuel system components before this particular mitigation option is put in place by ARB.[3] The Mitigation Study referenced in the Initial Statement of Reasons evaluated the effect on NOx and other pollutant emissions of adding DTBP to biodiesel blends, but it did not assess safety, material compatibility, and other potential issues.[4] Bosch maintains that these issues, which are discussed briefly below, must be investigated and taken into account by ARB prior to the establishment of this NOx mitigation measure.

ADF 2-1

1 Initial Statement of Reasons at 23.

2 *Id.* at 59.

3 A 1.0 percent level of DTBP in B20 would mean an overall blend composition of 80 percent CARB diesel, 19 percent B100, and 1 percent DTBP. As CARB made clear in an earlier version of the proposed ADF regulation, this composition can be obtained by blending 80 percent CARB diesel with 20 percent B100, where the B100 itself consists of 95 percent neat biodiesel and 5 percent DTBP.

4 *See Final Report – CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California, "Biodiesel Characterization and NOx Mitigation Study"* (Oct. 2011), available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20111013_CARB%20Final%20Biodiesel%20Report.pdf.

As an organic peroxide, DTBP may cause the embrittlement of elastomer-based fuel system components such as hoses and sealings. In this regard, the strong, negative effect that peroxides present in aged gasoline and E10 have been shown to have on such automotive components is highly relevant.[5]

ADF 2-2

Moreover, compared to CARB diesel, DTBP (CAS No. 110-05-4) has a low boiling point (111 °C), a low flash point (12 °C), and is a volatile substance.[6] Adding it to a blend of CARB diesel and B100 will reduce significantly the flash point of the resulting fuel blend, thereby leading to a potential safety hazard, while DTBP's high volatility creates a serious risk of cavitation in the high-pressure pumps and fuel injectors used in diesel engines and fuel systems. DTBP's thermal decomposition to acetone and other low-boiling point hydrocarbons further increases the volatility of the resulting fuel blend,[7] thus exacerbating these safety and cavitation concerns.

ADF 2-3

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5 *See, e.g.,* Chevron Corp., *Motor Gasolines Technical Review* (2009), at 41 ("Peroxides can . . . attack plastic or elastomeric fuel system parts"), available at http://www.chevronwithtechron.com/products/documents/69083_MotorGas_Tech_Review.pdf; DuPont Dow Elastomers, *Viton® - Excelling in Modern Automotive Fuel Systems* (1999), at 13 (hydroperoxides "decompose, forming free radicals that may attack some elastomers . . . [and] ultimately result[] in "embrittlement"), available at http://www.biofuels.coop/archive/viton.pdf.

6 *See* NIOSH, *International Chemical Safety Card #1019*, available at http://www.cdc.gov/niosh/ipcsneng/neng1019.html; *see also* National Library of Medicine Toxicology Data Network, Hazardous Substances Databank, available at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/r?dbs+hsdb:@term+@na+BIS(1,1-DIMETHYLETHYL)PEROXIDE.

7 *See* Sebbar and Bockhorn, *Di-Tert-Butyl Peroxide Combustion with Air: Ignition, Laminar Flame Velocities*, available at http://cost.ensic.univ-lorraine.fr/cost/fileadmin/utilisateurs/COST_Documents/Sofia/WG5/WG5_11_Sebbar.pdf; Cafferata and Manzione, *Kinetics and Mechanism of Gas-Phase Thermolysis Using Headspace-Gas Chromatographic Analysis*, available at http://chromsci.oxfordjournals.org/content/39/2/45.full.pdf.

DTBP is commonly used as a polymerization catalyst in olefin chemistry. If added to biodiesel that has been produced through the transesterification process, it can be expected that the DTBP, separate and apart from any NOx emissions effect, will catalyze the polymerization of unsaturated fatty acid methyl esters in the biodiesel, eventually resulting in severe lacquer formation in the fuel circuit. Ultimately, the sticking/seizure of hydraulic system components may occur; at the very least, such events cannot be ruled out as a possibility. These events, of course, could lead to improper fuel control in the diesel engine, potentially resulting in:

ADF 2-4

- Rough and erratic vehicle operation;
- Under-fueling (with an inability to start the engine and/or low power); or
- Over-fueling (with excessive tailpipe emissions of NOx and other pollutants, consequential failures, and/or sudden vehicle breakdowns).

The last possibility is particularly important given that the DTBP is meant to mitigate the NOx emissions impact of biodiesel blend (i.e., ≥B10) usage.

Bosch also observes that the temperature inside high-pressure hydraulic systems often exceeds 140 °C. This temperature may promote the decomposition of DTBP before it is able to serve its intended purpose as a NOx mitigator during the combustion process. Notably, the thermal decomposition of DTBP is considerably faster than the thermal decomposition of 2-ethylhexyl nitrate.[8]

ADF 2-5

[8] *See* Nandi, *The Performance of Di-Tertiary-Butyl Peroxide as Cetane Improver in Diesel Fuels*, available at http://web.anl.gov/PCS/acsfuel/preprint%20archive/Files/41_3_ORLANDO_08-96_0863.pdf.

* * *

For all of the above reasons, Bosch strongly believes that before ARB establishes DTBP as a NOx mitigation option for biodiesel blends, substantial work should be done to assess the potential safety concerns and material compatibility and system performance and durability issues associated with using DTBP as a biodiesel blend additive. ADF 2-6

Bosch appreciates the opportunity to comment on the proposed ADF regulation. Should ARB have any questions or need any additional information, please feel free to contact either one of us.

Sincerely,

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2_OP_ADF_Bosch2013 Responses

7. Comment: **ADF 2-1**
The comment states concerns with the use of DTBP as an option for NOx mitigation.

Agency Response:
Please see the paragraph regarding the study and use of DTBP in response **ADF 1-6.**

8. Comment: **ADF 2-2**
The comment states that the use of DTBP as a NOx mitigation option may harm system components such as hoses and seals.

Agency Response:
Please see the paragraph regarding the study and use of DTBP in response **ADF 1-6.** EPA's and additive manufacturers' additional studies and analysis of DTBP covers the durability of systems such as hoses and seals.

9. Comment: **ADF 2-3**
The comment asserts that the use of DTBP as a NOx mitigation option may change the flash point of the fuel blend.

Agency Response:
Please see the response regarding the study and use of DTBP in response **ADF 1-6.**

10. Comment: **ADF 2-4**
The comment asserts that the use of DTBP with biodiesel may lead to fuel degradation and poor performance.

Agency Response:
Please see the paragraph regarding the study and use of DTBP in response **ADF 1-6.**

11. Comment: **ADF 2-5**
The comment asserts that high engine temperatures experienced in high pressure hydraulic systems may decompose DTBP prior to being able to mitigate NOx.

Agency Response:
These effects were not observed in the studies ARB sponsored, since the DTBP was used in modern engines with high pressure fuel systems and DTBP effectively mitigated NOx. For more information on DTBP, please see the paragraph regarding the study and use of DTBP in response **ADF 1-6.**

12. Comment: **ADF 2-6**
The comment states that additional work should be done to assess potential safety, compatibility, performance, and durability issues with DTBP prior to use as a NOx mitigation option.

Agency Response:
Please see the paragraph regarding the study and use of DTBP in response **ADF 1-6.**

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Comment letter code: 3-OP-ADF-WSPA2013

Commenter: Catherine Reheis-Boyd

Affiliation: Western States Petroleum Assoc.

The following letter was submitted to the ADF Docket during the 45-day comment period.

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3_OP_ADF
_WSPA2013

Western States Petroleum Association
Credible Solutions • Responsive Service • Since 1907

Catherine H. Reheis-Boyd
President

December 11, 2013

Clerk of the Board, Air Resources Board,
1001 I Street,
Sacramento, CA 95814
http://www.arb.ca.gov/lispub/comm/bclist.php

Re. **Public Hearing to Consider the Proposed Regulation on the Commercialization of New Alternative Diesel Fuels**

The Western States Petroleum Association (WSPA) appreciates the opportunity to submit written comments for the record on the above proposed rulemaking. WSPA is a non-profit trade association representing twenty-seven companies that explore for, produce, refine, transport and market petroleum, petroleum products, natural gas and other energy supplies in California, and five other western states.

We understand the hearing has been postponed until March of 2014, however the record on this item is open for submittals through the December 12th hearing, and then will be reopened again in March for further comment on any staff proposed revisions. WSPA has provided comments on the 45 day package in the attachment, and would be happy to discuss these further with ARB if needed.

WSPA has worked with ARB over the past few years on this alternative diesel regulation and believes the approach outlined in the proposed regulation is the best based on the large number of issues and considerations. We are prepared to consider the anticipated additional proposals that will be discussed during a staff workshop in the New Year. ADF 3-1

Sincerely,



WSPA COMMENTS ON CARB'S PROPOSED REGULATION ON THE COMMERCIALIZATION OF NEW ALTERNATIVE DIESEL FUELS

- WSPA suggests ARB provide more details on how the factors in the regulation were calculated because it is not as straightforward as stated; especially if the reader doesn't know that ARB assumed that 5% biodiesel is neutral, and that ARB used B5 as the baseline rather than CARB Diesel. ADF 3-2
- The proposed regulation is missing a heading section on page A-21. There should be a section 2293.5(d) heading at the top of the page. ADF 3-3
- Appendix C: We believe there is an error in the regulation. ARB discusses NOx mitigation on page 174 under "Cost to use low NOx Diesel". ARB states it requires a 4:1 ratio of renewable diesel to CARB diesel to mitigate NOx for B20. The study shows a 2.75 to 1 ratio of renewable diesel to biodiesel will mitigate NOx, which turns the hydrocarbon ratio into a 2.2 to 1 ratio of renewable diesel to CARB diesel for B20 blends. This is confirmed in the ARB staff's September workshop slide pack on page 24. ADF 3-4
- We would like to ask ARB about a regional average compliance approach, and whether this would be acceptable. ADF 3-5

- **2293.2 Definitions**

Changes to definitions should be made as follows:

Biodiesel Blend ADF 3-6

A biodiesel blend may consist of biodiesel blended with petroleum based diesel, renewable diesel, GTL, and/or other Fischer-Tropsch fuels. Therefore, the term "petroleum based" within the definition of "Biodiesel Blend" should be replaced with the broader term "CARB diesel" as follows:

"Biodiesel Blend" means biodiesel blended with ~~petroleum based~~ **CARB** diesel fuel."

We assume CARB diesel includes GTL, renewable diesel, etc.

"Diesel Substitute" ADF 3-7

"Diesel Substitute" is a circular term as defined in the proposed regulation, because renewable diesel is both CARB diesel and under this definition a "Diesel Substitute". We believe the term "Low Emission Diesel" or something similar conveys ARB's intent better than the term "Diesel Substitute". "Diesel Substitute" should be replaced with this updated term throughout the proposed regulation and have the following definition:

"~~Diesel Substitute~~ **Low Emission Diesel**" means ~~any liquid fuel that is intended for use with CARB diesel or CARB diesel blends in a compression ignition engine~~ **a type of CARB diesel fuel that can reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel**. "~~Diesel substitute~~ **Low Emission Diesel**" includes, but is not limited to, renewable diesel; gas-to-liquid fuels; Fischer-Tropsch fuels; CARB diesel blended with additives specifically formulated to reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel; and CARB diesel specifically formulated to

reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel.

ADF 3-7 cont.

"Hydrocarbon"

The definition of "Alternative diesel fuel" includes the phrase "…does not consist solely of hydrocarbons,…" as follows:

> "Alternative diesel fuel" or "ADF" means any non-CARB diesel fuel used in a compression ignition engine that does not consist solely of hydrocarbons, and is not subject to a specification under title 13, CCR, section 2292. All ADFs that are substantially similar to an ADF subject to an approved Executive Order or MOU shall be deemed to fall within the class of ADFs subject to that same approved Executive Order or MOU.

Coupled literally with ARB's proposed definition of "hydrocarbon" below, this creates a contradiction with the reality that even petroleum based CARB diesel (which would not otherwise be considered an ADF) contains low levels of other elements such as sulfur and nitrogen which are residual impurities from the refining process. To remove this contradiction and avoid potential confusion, we recommend ARB instead adopt the definition used in ASTM D975 for "hydrocarbon oil" as the definition for "hydrocarbon" in the ADF regulation as follows:

ADF 3-8

> *hydrocarbon* ~~*oil, n*~~ —homogeneous mixture or solution with elemental composition primarily of carbon and hydrogen and also containing sulfur, oxygen or nitrogen from residual impurities and contaminants and excluding added oxygenated materials.

- **Section 2293.3 Exemptions**

Paragraph 2293.3 (b) exempting CARB diesel from the ADF regulation states CARB diesel blends are comprised solely of CARB diesel and one or more diesel additives that comprise "in the aggregate" no more than 1.0 percent by volume of the CARB diesel blend. EPA limits additives in diesel fuel to 1 percent individually per 40 CFR80.521(b)(1) . We believe ARB should do the same for consistency. Therefore, section 2293.3 (b) should be modified as follows:

> "CARB diesel blends comprised solely of CARB diesel and one or more diesel additives **individually** comprising ~~in the aggregate~~ no more than 1.0 percent by volume of the CARB diesel blend. This provision does not apply to additives used pursuant to the mitigation measures specified in Appendix 1;"

ADF 3-9

40CFR80.521 is accessible via the Electronic Code of Federal Regulations at:

http://www.ecfr.gov/cgi-bin/text-idx?SID=ca97c6c0579783920cb5aab1e3ae3def&node=40:17.0.1.1.9.9.63.11&rgn=div8

Paragraph 2293.3 (c) - With regard to ADF's used in fleets comprised of 95% or more NTDE vehicles, ARB should include the NTDEs when determining the Effective Blend Level as that volume is leading to emissions reductions. It should not be up to the Executive Officer as to if/whether it should or shouldn't be included. Is it included in the "VM" category? If so, it should be specified.

ADF 3-10

- **Section 2293.4 General Requirements Applicable to All ADFs**
  ARB made no changes addressing the WSPA comment, "Part (b) discusses that an ADF must meet all of DMS's regulatory requirements/standards. We can foresee a possible problem whereby the two agencies (ARB and DMS) adopt current ASTM versions at different times – thereby making it difficult if not impossible to comply with both versions for a period of time."

ADF 3-11

- **Section 2293.5 (c) Regarding *"Stage 3A: Commercial Sales Subject to Mitigation"***

Section 2293.5(c)(2) states,

> "Based on the analysis in (c)(1), the Executive Officer shall estimate the year(s) in which the effective ADF blend level is projected to reach 25%, 50%, 75%, and 95% of the significance threshold."

ADF 3-12

What action by ARB occurs if/when the 25% and 50% thresholds are reached? What ,if any, requirements are placed on Stage 3A ADF "producers", "importers" and "suppliers" before the 75% significance threshold is reached?

Section 2293.5(c)(3) states that,

> "…Once the 75% level is reached, all suppliers of an affected ADF shall provide monthly reports to the Executive Officer, as specified in section 2293.8, additionally at this point all producers and importers of the affected ADF shall submit a mitigation plan in accordance with 2293.5(c)(5);…"

Please explain and define the word "suppliers", as this term is not included within the Section 2293.2 definitions. An example using biodiesel would be helpful under scenarios where:

ADF 3-13

- One party imports B100 into the state under the LCFS importer definition,
- The importer sells some portion of the B100 to others within the state,
- Some portion of those in-state B100 buyers may use the biodiesel to make/sell B5 blends, while others may use the B100 to make/sell B10-B20 blends, and
- The original B100 importer will not necessarily know how the in-state buyers of the B100 used the B100 (B5 blends? B10? B20? Re-sold again as B100 to another party?)

Section2293.5(c)(4) states that:

> "Once the effective ADF blend level has reached 95% of the significance threshold, the requirement to apply mitigation becomes effective and any producer or importer of the affected ADF shall comply with the terms of the mitigation plan by which they are covered. Each mitigation plan shall apply mitigation on a proportion of their total fuel equal to difference between the projected effective blend level and 95 percent of the significance level for each year."

ADF 3-14

Using biodiesel as an example, if the 95% significance threshold is reached all B100 producers/importers should not have to apply a mitigation plan. If mitigation is only required on B10

to B20 blends, the "suppliers" of these B10 to B20 blends should be the responsible parties and not necessarily the producers/importers of B100.

ADF 3-14 cont.

- **Section 2293.5 (c) Regarding *"Stage 3B: Commercial Sales Subject to No Mitigation"***

If ARB has determined no significance level for an ADF (the fuel is a Stage 3B ADF) and no mitigation measures and/or sales restrictions are required for that ADF, why then does a "fuel provider" (term not defined) need to submit quarterly reports to the ARB Executive Officer? This reporting seems unnecessary and redundant as ARB implies the production/import volume information will already be captured within LCFS quarterly submittals. Please explain the purpose of this requirement.

ADF 3-15

- **2293.6 Significance Thresholds and Effective ADF Blend Levels.**

Net Biodiesel Volume (NBV) is defined as:

> NBV = net volume of biodiesel used in compression-ignition engines in California, excluding gallons used in B5 or less, expressed in gallons.

Which parties will have to report what information to ARB in order for the Executive Officer to calculate this "NBV"? We do not believe "suppliers" and "fuel providers" blending/selling B0-B5 should have any reporting requirements. Rather, the EO should calculate this NBV via the reporting by the blenders/sellers of B6-B20.

ADF 3-16

Volume of Animal-fats-based biodiesel (AB) is defined as:

> AB = volume of animal-fats-based biodiesel used in compression-ignition engines in California, excluding gallons used in B5 or less, expressed in gallons.

Since B5 blenders should not have any reporting requirements placed on them under the ADF regulation, please confirm ARB will obtain information on this AB volume from the blenders of B6-B20 who use animal-fats-based biodiesel in those blends. If the amount of animal fat based biodiesel is unknown to the B6-B20 blender, will the blender be able to report it as zero/unknown? This may trigger the significance threshold sooner, but it would provide the B6-B20 blender with a reporting compliance path.

ADF 3-17

New Technology Diesel Equipment (NTDE) impact on the Effective Blend Equation:

Why has ARB changed its approach from including an NTDE weighting factor in the effective blend calculation to instead propose no benefits from NTDE's until they comprise 95% or more of the in-service heavy duty fleet?

- **Section 2293.8 (b)(2) states (highlighted emphasis added),**

"Except as provided in this paragraph, a person operating within Stage 3A must submit monthly reports to the Executive Officer. Each report shall include the following:

(A) The volume of ADF and ADF blend offered, supplied, or sold during each month;

(B) Results of a specified number of representative samples, for fuel properties by test methods specified in the MOU;

ADF 3-18

(C) The volume of other applicable quantity of the mitigation strategy used during each month;

(D) The blend rate of mitigation strategies used during each month, if applicable.

If the Executive Officer publishes notice that the effective ADF blend level has reached 75% of the significance threshold pursuant to section 2293.6(c)(2) and (3), any person subject to this provision shall report the information specified in (1)-(3) above for the affected ADF by the end of each month following the notice publication."

ADF 3-18 cont.

Please define "a person operating within Stage 3A". It may not necessarily be the ADF producer/importer. It might instead be a supplier of an ADF blend - correct? In the case of biodiesel blending, is the "supplier" of B6+? or B10+? the person who must submit reports? If a biodiesel producer/importer sells the B100 to others within California, or only uses the biodiesel in B5 blends, what is this producer/importer required to report? Please note that the biodiesel producer/importer will not necessarily know if subsequent purchasers intend to use the biodiesel in B5 blends, B6-10 blends, and/or B10+ blends.

ADF 3-19

Frequency of Reporting for Stage 3A ADF's - In previous workshop drafts of the ADF regulation, quarterly reports were required until the effective ADF level reached 75% of the significance threshold. Only then would monthly reports be required. We do not see a reason for monthly reporting before the 75% significance threshold is reached. Also, section 2293.5(c) (3) as currently proposed by ARB only states that reporting shall begin on a monthly basis after the 75% significance level is reached. The frequency of reporting in Section 2283.8(b) should be revised to match that in 2293.5(c)(3).

ADF 3-20

Also in the proposed regulation, the Stage 3A reporting requirements are now listed as items 2293.8(b)(2)(A) through (D). Please correct the typographical error where these are referred to as items "(1)-(3)" in the last paragraph of Section 2293.8(b)(2).

ADF 3-21

- **Section 2293.8(b)(3) –Reporting for Stage 3B ADF's**

Section 2293.8(b)(3) states that Stage 3B ADF reporting is required monthly. However, section 2293.5 states that for Stage 3B alternative diesel fuels, reporting shall be on a quarterly basis. Per our earlier comment we believe ARB will be able to obtain this information on a quarterly basis from LCFS quarterly submittal reports. The monthly reporting requirement in 2293.8(b)(3) should be removed.

ADF 3-22

3_OP_ADF_WSPA2013 Responses

13. Comment: **ADF 3-1**
The comment supports the approach outlined in the ADF proposal.

Agency Response: ARB staff appreciates the comment in support of adopting the ADF regulation.

14. Comment: **ADF 3-2**
The comment suggests ARB provide more details on how the factors in the regulation were calculated.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant.

15. Comment: **ADF 3-3**
The comment states the proposed regulation is missing a heading.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant, because the provisions discussed are not in the 2015 proposal.

16. Comment: **ADF 3-4**
The comment suggests that the renewable diesel blending ratio is incorrect in the 2013 ADF proposal.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant because the provisions discussed are not in the 2015 proposal.

17. Comment: **ADF 3-5**
The comment suggests a regional average compliance approach.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant because the provisions discussed are not in the 2015 proposal.

18. Comment: **ADF 3-6**
The comment suggests a change to the definition of “biodiesel blend”.

Agency Response:
The comment referenced the 2013 proposal but this definition was in the 45-day version of the 2015 proposal. ARB staff agrees with the comment and updated the definition of biodiesel blend in the 15-day changes since CARB Diesel includes non-petroleum based diesel fuel such as renewable diesel..

19. Comment: **ADF 3-7**
The comment suggests a change to the definition of “diesel substitute”.

Agency Response:
The diesel substitute definition has been eliminated as part of the 15-day changes, as noted in response **ADF 1-5**. Therefore, the comment is no longer relevant.

20. Comment: **ADF 3-8**
The comment points out an inconsistency between the definitions for “alternative diesel fuel” and “hydrocarbon” in the ADF proposal.

Agency Response:
ARB staff addressed this issue by modifying the proposed regulation as part of the 15-day changes. The hydrocarbon definition was clarified to indicate that residual impurities may remain in the final product.

21. Comment: **ADF 3-9**
The comment suggests modifications to additive volume limits for CARB diesel exempted from the ADF proposal.

Agency Response:
Additives are generally used in extremely small volumes (the parts per million level) and in the aggregate would not reach or exceed one percent by volume of the total mixture. CARB diesel, specifically, contain additives (usually for lubricity and conductivity) that in combination account for well under 1 percent of fuel volume. ARB believes the requested change would have some potential to allow for avoidance of the ADF requirements through characterization of blendstocks as additives. Therefore, ARB declines to modify the proposal . Additionally, ARB understands that EPA generally registers diesel additives for use up to 0.25 percent, not one percent. See **ADF 1-6** for a discussion of steps needed to get to the higher levels of additive.

22. Comment: **ADF 3-10**
The comment suggests additional specificity for determining Effective Blend Levels.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant, since the term “effective blend level” is not in the 2015 proposal.

23. Comment: **ADF 3-11**
The comment states that compliance with the ADF proposal may be difficult due to conflicting American Society for Testing and Materials (ASTM) standards. The commenter suggests that ARB and the California Department of Food and Agriculture's (CDFA) Division of Measurement Standards (DMS) could adopt current ASTM volumes at different times, making it difficult or impossible to comply with both.

Agency Response: Regarding the risk of conflicting standards: Section 2293.4 of the proposed regulation requires ADFs to meet all of the California Department of Food and Agriculture's (CDFA) Division of Measurement Standards (DMS) regulatory requirements as well as any other applicable State law. CDFA regulations require that "[d]iesel fuel shall meet the specifications set forth by the ASTM in the latest version of Standard Specification for Diesel Fuel Oils D975 contained in the ASTM publication entitled: Annual Book of ASTM Standards, Section 5, Volume 05:01, except the sulfur content shall not exceed the maximum specified by any California state law." Since the ADF regulation refers applicants to the DMS standards, which incorporates this specific ASTM standard, the two programs will always be referring to the same version of ASTM requirements. Therefore, there is no risk of having to comply with two different versions of the ASTM standard.

24. Comment: **ADF 3-12**
The comment requests clarification on the requirements for regulated persons with regards to effective ADF blend level significance thresholds.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant. As noted in the response to **ADF 3-10**, the term "effective blend level" is not in the 2015 proposal.

25. Comment: **ADF 3-13**
The comment requests clarification on the requirements for suppliers with regards to the 75 percent mitigation significance threshold, which would have led to reporting requirements in the 2013 proposal. .

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant, because the provisions discussed are not in the 2015 proposal.

26. Comment: **ADF 3-14**
The comment requests clarity on the requirements for mitigation under the 95 percent significance threshold.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant because the provisions discussed are not in the 2015 proposal.

27. Comment: **ADF 3-15**
The comment requests clarity on the reporting requirements when ARB has determined no significance level for an ADF.

Agency Response:
The comment is specific to the 2013 proposal, and is no longer relevant. The provisions discussed are not in the 2015 ADF regulation. To the extent that further information provides clarity on the path, ARB staff conducted a statistical analysis on the provisions of the ADF regulation, which can be found in Chapter 6 of the ADF Staff Report, and a supplemental analysis in Appendix G of the same document. Additionally, a statistical summary appears in **ADF 8-1**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.

28. Comment: **ADF 3-16**
The comment states that "suppliers" and "fuel providers" blending and selling B0-B5 should have no requirements for reporting net biodiesel volume.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant because the provisions discussed are not in the 2015 proposal.

29. Comment: **ADF 3-17**
The comment requests clarity on how ARB will obtain information to determine the volume of animal-fats-based biodiesel.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant because the provisions discussed are not in the 2015 proposal. The requirement to differentiate between animal and vegetable based on biodiesel was replaced by measurements on saturation (see section 2293.6 of the regulation), which is an objective performance standard that does not depend on distinction between animal and vegetable feedstocks.

30. Comment: **ADF 3-18**
The comment requests clarity as to why ARB changed its approach for determining NTDE impacts on the effective blend equation.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant because the provisions discussed are not in the 2015 proposal.

31. Comment: **ADF 3-19**
The comment requests ARB define "a person operating within Stage 3A."

Agency Response:
The suggested definition is unnecessary. An individual or entity subject to the provisions of Stage 3A in-use requirements is by implication, "a person operating within Stage 3A." Therefore this will only apply to entities subject to the ADF provisions under Stage 3A. Generally, the Stage 3 provisions of the ADF proposal would apply to ADF producers/importers, blenders, distributors, and retailers. Page 14 of the Staff Report, under the heading titled "Who is affected by this proposed regulation?" as well as sections 2293.1 and 2293.4 of the proposed regulation provides additional clarity.

32. Comment: **ADF 3-20**
The comment requests a change to reporting frequency related to reaching 75 percent of the mitigation significance threshold.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant because the provisions discussed are not in the 2015 proposal.

33. Comment: **ADF 3-21**
The comment points out a typographical error, where items A-C were referred to as 1-3.

Agency Response:
The comment is specific to the 2013 proposal and is no longer relevant because the provision is not in the 2015 proposal.

34. Comment: **ADF 3-22**
The comment points out a typographical error, which referred to monthly reporting rather than quarterly. .

Agency Response:
This typographical error was corrected in the 15-day changes.

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Comment letter code: 4-OP-ADF-Oberon2013

Commenter: Brittany Syz

Affiliation: Oberon Fuels

The following letter was submitted to the ADF Docket during the 45-day comment period.

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December 12, 2013

California Environmental Protection Agency, Air Resources Board

Re: **Comments to the Proposed Regulation on the Commercialization of New Alternative Diesel Fuels released October 23, 2013**

To Whom It May Concern:

Oberon Fuels is supportive of the proposed CARB Alternative Diesel Fuel Regulation regarding the Commercialization of New Alternative Diesel Fuels. As a San Diego-based, innovative company, we are a case study for the importance of this regulation and its importance in streamlining the certification procedure.

Oberon Fuels has developed an innovative process to bring dimethyl ether (DME) to the market. DME is a clean-burning, non-toxic, potentially renewable fuel. Its high cetane value and quiet combustion, as well as its inexpensive propane-like fueling system, make it an excellent, inexpensive diesel alternative that will meet strict emissions standards and assist in lowering greenhouse gases. Ideal uses for DME in North America are in the transportation, agriculture, and construction industries.

DME has been used for decades as an energy source in China, Japan, Korea, Egypt, and Brazil, and it can be produced domestically from a variety of feedstocks, including biogas (animal and food waste, landfill gas, and waste water treatment gas) and natural gas. The Oberon process is even more efficient when the carbon dioxide from biogas is incorporated into the process. This ability to convert a variety of methane and carbon dioxide sources to DME, enables the sequestration of two greenhouse gases to produce a cleaner burning fuel.

Oberon Fuels' first facility in Brawley, California is currently producing fuel-grade DME that is being used in several trucking demonstrations. Oberon is also currently navigating the CARB Tier 1 Multimedia review for fuel certification. Additionally, ASTM recently passed a new standard specification for "Dimethyl Ether for Fuel Purposes." Oberon Fuels has also submitted biogas to DME pathways to the EPA for consideration under the Renewable Fuel Standard to receive RIN credits. The production and use of DME has surpassed the research phase and is now solidly in the development phase, soon to be in commercialization production (2015).

On June 6, 2013, Volvo Trucks North America announced that it will be commercializing DME heavy-duty trucks in 2015. Two weeks later, Mack Trucks also announced its plans for commercializing DME-powered trucks in 2015. In addition, Volvo, Safeway, and Oberon were awarded a grant for Safeway to test drive to Volvo trucks running on Oberon DME, driving typical routes in 2014.

Greenhouse Gas (GHG) Reduction; AB32 goals

DME will assist in GHG reduction, as it will contribute to the displacement of the 2.6 billion gallons of diesel currently used in California. Pure DME contains no sulfur compounds, which makes it a clean burning fuel that generates no SOx or particulate matter in the exhaust gas. Additionally, because DME can be made from biogas, the production process sequesters both carbon dioxide and methane, which further reduces GHG emissions in California.

Volvo has tested DME engines in heavy-duty applications since 1999, first with a DME-powered bus. Current Volvo demonstrations of DME in Europe show a 95% reduction in CO_2 emissions for commercial operations. These results prove that production of DME will continue to assist with California's emission requirements codified in AB32.

Proposed Regulation Streamlines Fuel Certification Process

The proposed regulation will allow companies to more effectively navigate the fuel certification process. This regulation proposes to outline the specific testing and emissions evaluations that CARB requires when certifying a fuel. By compiling the information, companies will only have to review one source of requirements to determine what they need to test for during the certification. Providing the specific criteria ahead of time will also streamline the process and allow for companies to be able to prepare themselves for the required multimedia evaluation. While we understand that many of the provisions of this regulation are already legally required, we believe that placing the framework in one regulation will increase understanding and allow innovative companies to more quickly bring safe and viable alternative fuels to market.

Local Benefits

Streamlining the commercialization of DME will immediately assist with reduced emissions, better air quality, and more green jobs in California. Every time DME is used as a fuel, it will replace the use of diesel, therefore, immediately reducing the particulate matter, SOx, and NOx released from diesel combustion.

The DME plant in Brawley currently supports 10 full-time operators, not including the temporary jobs created by the construction of the plant. Oberon is currently building an additional plant in Brawley and has plans to have several more plants online by the beginning of 2015. Each plant will support 10 full-time operators. The number of corporate jobs will also grow as Oberon builds more plants to serve more markets.

Oberon strongly believes that the proposed CARB Alternative Diesel Fuel Regulation will allow us to more quickly bring a viable and clean fuel to market, while complying within all environmental regulations.

Oberon Fuels appreciates the opportunity to offer these comments and suggestions.

Sincerely,

Brittany Applestein Syz

Vice President of Business Development & General Counsel

Oberon Fuels, Inc.

4_OP_ADF_Oberon2013 Responses

35. Comment:
The comment supports the adoption of the ADF regulation.

Agency Response:
ARB staff appreciates the comment in support of the ADF regulation.

Comment letter code: 5-OP-ADF-POET2013

Commenter: Brian Guarrici

Affiliation: POET

The following letter was submitted to the ADF Docket during the 45-day comment period.

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5_OP_ADF
_POET2013

POET
HUMAN + NATURE
P / 605 965 2200 4615 N. LEWIS AVE. SIOUX FALLS, SD 57104 POET.COM

December 11, 2013

By Electronic Mail

Clerk of the Board
California Air Resources Board
1001 I Street
Sacramento, California 95812

Re: Proposed Regulation for Commercialization of Alternative Diesel Fuels

Dear Madam:

On behalf of POET, LLC ("POET"), I write to endorse the Comments being submitted today by Growth Energy on the proposed regulatory action concerning alternative diesel fuels to be considered at the Board's two-day hearing this week. POET is a member of Growth Energy and agrees with Growth Energy that the CARB staff's proposal requires significant, but feasible, revisions. POET is a strong supporter of biodiesel fuels as part of a national strategy to achieve energy independence and sustainable transportation fuels. The key point in Growth Energy's comments is that simple changes are needed in the proposed regulation to protect against unintended increases in smog-forming emissions. As one of the Nation's leading suppliers of ethanol, POET seeks only to ensure that all alternative fuels are required to appropriately mitigate any increases in emissions of any pollutant with adverse health effects associated with the use of those fuels.

Three points in the Growth Energy comments warrant emphasis.

First, the available data demonstrate that, without mitigation, the increased use of biodiesel fuels that will result from implementation of the low-carbon fuel standard ("LCFS") regulation can be expected to increase emissions of oxides of nitrogen ("NOx"). The California Environmental Quality Act ("CEQA") requires mitigation of the risks of increased NOx emissions, in the locations and at the times when those emissions would occur. POET urges the Board to consider carefully its obligations under CEQA, as recently clarified by the Fifth District Court of Appeal in *POET LLC et al. v California Air Resources Board*, (2013) 218 Cal. App. 4th 681. ADF 5-1

Second, POET shares Growth Energy's concern that the Board not adjourn the important task of assessing the environmental aspects of the proposed regulation to a *post hoc* process, after the Board has committed itself to the proposed ADF regulation. The Court of Appeal has addressed the relevant requirements of CEQA and CARB's implementing regulations in its recent decision. *See* 218 Cal. App. 4th at 719-32. ADF 5-2

Finally, like Growth Energy, POET is skeptical that all required materials have been placed in the "rulemaking file" for this proposed regulatory action. *See* Growth Energy Comments at 5, 14-15. POET is particularly concerned by the absence of complete data from testing conducted on CARB's behalf to characterize NOx emissions when engines are operated on biodiesel, as described in a report by Mr. Robert Crawford, which is included in Growth Energy's Comments. CARB must ensure that the rulemaking file is complete and must allow the public adequate opportunity to study and comment on all relevant data. As Growth Energy explains in its Comments, the California Administrative Procedure Act would not permit the Board to take further action on this regulatory item until the defects in the rulemaking file have been addressed.

ADF 5-3

Thank you for considering our Comments and those of Growth Energy, as well as other stakeholders in this important rulemaking effort.

Sincerely,

Brian Guarraci
Senior Counsel
POET, LLC

5_OP_ADF_POET2013 Responses

36. Comment: **ADF 5-2**

Agency Response:
The response to this comment is in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

37. Comment: **ADF 5-1**
The commenter urges the Board to consider its obligations under CEQA with regards to mitigation of NOx emissions from biodiesel use.

Agency Response:
The comment is specific to the 2013 proposal. In the 2015 proposal, biodiesel use at blend levels less than the NOx control levels are offset and biodiesel use at blend levels above the NOx control levels are required to be mitigated by in-use controls .

38. Comment: **ADF 5-3**
The comment questions whether all required materials have been placed in the rulemaking file for the ADF proposal.

Agency Response:
All of the documents on which ARB relied in the ADF rulemaking have been placed in the rulemaking file and identified in the Staff Report released December 30, 2014 or the public notice of modifications to the proposal dated May 22, 2015. Separate from the rulemaking file that has been made available from the time the Staff Report was released, ARB has maintained a group of web pages dedicated to ADF that includes other materials, including workshop feedback submitted to ARB prior to the start of the rulemaking process:http://www.arb.ca.gov/fuels/diesel/altdiesel/biodiesel.htm#background.

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Comment letter code: 6-OP-ADF-Growth2013

Commenter: Tom Buis

Affiliation: Growth Energy

The following letter was submitted to the ADF Docket during the 45-day comment period.

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6_OP_ADF_Growth2013 Responses

39. Comment: **ADF 6-1**

Agency Response:
This comment letter was entirely reproduced in **3_B_ADF_GE** (responses **ADF B3-12** through **ADF B3-111**) and is addressed in that section, later in this document.

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Comment letter code: 7-OP-ADF-CRE

Commenter: Harry Simpson

Affiliation: Crimson Renewable Energy

The following letter was submitted to the ADF Docket during the 45-day comment period.

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7_OP_ADF _CRE

7_OP_LCFS _CRE

CRIMSON RENEWABLE ENERGY, LP

17731 Millux Road
Bakersfield, CA 93311
Tel: (661) 617-8610
Fax: (720) 475-5399

February 13, 2014

Chairwoman Mary Nichols
California Air Resources Board
1001 I Street
Sacramento, CA 95812

CC: All California Air Resources Board Members

Via online submission at http://arb.ca.gov/lispub/comm/bclist.php.

RE: comments regarding the proposed Alternative Diesel Fuel (ADF) Regulations and the Low Carbon Fuel Standard

Dear Chairwoman Nichols:

As California's largest in-state producer of biodiesel (we utilize used cooking oil and distiller's corn oil to produce an ultra-low carbon alternative diesel fuel with an average quarterly carbon intensity for 2013 and 2014 of 12 to 16.5) , we are naturally very interested in the proposed Alternative Diesel Fuel (ADF) Regulations and the Low Carbon Fuel Standard (LCFS). Any proposed ADF regulations and/or changes to LCFS could have a profound impact on the California biodiesel market and on the ultimate viability of our Bakersfield biodiesel plant. The Crimson team would like to thank members of the ARB staff and Board Members for their hard work on this rulemaking and their ongoing willingness to engage with us and other industry stakeholders. We greatly appreciate the time that ARB staff members have taken and the positive relationships they've encouraged.

Economic Impact

Before getting into our comments on the proposed ADF regulations and the future direction of LCFS, I would like to provide some additional information about our biodiesel production facility in Bakersfield, California. Specifically, I hope this information will provide the Air Resources Board and its affiliated regional air districts a context to better understand the economic impact of proposed ADF regulations and LCFS.

Our biodiesel production facility in Bakersfield currently has 25 full time employees, and an additional 6 long term, full-time contractors. The plant was built in order to serve the market for very low carbon fuels created by the LCFS.s Based on our spending in 2014, our annual direct economic contribution was $40 million, of which approximately 87% was spent within California and significant portion of this was spent in Bakersfield and other parts of the Central Valley. The average annual 2014 compensation per person employed at the plant not including the senior management positions is approximately $64,000. Furthermore, several of our plant employees came to us without the full range of experience that is required and we have invested significantly in their training.

We are also currently in the midst of an expansion project that began in early 2014 and will be completed in summer 2015 entailing a total investment of nearly $10 million. The first phase of this project was completed in May 2014 enabling us to increase our annualized production rate from 9.5 mil gal/yr to 14mil gal/yr. Upon completion, our plant capacity will grow to 22 mil gal/yr. At that point, the plant will make a direct economic contribution of $70 - $90 million per year (depending on raw material prices) with 89-93% of this being spent within California, and 36-38 full time employees and long-term contractors.

Thus we believe that our biodiesel production facility is making a strong and growing economic and job creation contribution locally (which is also considered an economically disadvantaged area) and within California. However, it is important to note that we are but one plant out of 5 current biodiesel producers. The California Energy Commission estimated that in 2014 biodiesel production within California will be approximately 40 million gallons. Based on our Bakersfield plant's spending this year, this would come out to a total direct economic contribution of approximately $122 million in 2014. The CEC has projected in-state biodiesel production to grow to 55 million gallons in 2016, representing an economic contribution of approximately $200 million. These figures deserve serious

ADF 7-1

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acknowledgement given the fact that the ADF Rulemaking will reduce the market opportunity for biodiesel in California and this would be disproportionately felt by in-state producers such as Crimson, especially given the markedly higher costs of operating in California as compared to elsewhere in the U.S. or internationally. The same is true if the ARB decides to push back the timeline for LCFS carbon reductions.

ADF 7-1 cont.

Emissions / Health Benefits

As we and other stakeholders have pointed out previously to ARB staff, biodiesel is a solution to very specific problems associated with petroleum diesel's emissions profile – namely the well-known toxics, particulates, and carcinogens that are currently causing unacceptable levels of respiratory illness in California, especially in the Central Valley, the areas surrounding the Port of Long Beach and Port of Los Angeles, and especially among California's children and elderly and its economically disadvantaged communities (such communities tend to be concentrated near industrial areas where truck traffic is disproportionately higher than in other communities). Indeed, "Biodiesel's reduction in PM emissions and associated risks" were acknowledged in the ARB staff presentations at previous ADF Rulemaking Workshops and some air districts in California are out of compliance for PM reductions. Besides PM reduction, biodiesel also provides significant reductions in polycyclic aromatic hydrocarbons (PAHs), nitrated PAHs, and the ozone potential of spectated hydrocarbons. According to the Union of Concerned Scientists and the American Lung Association (http://www.ucusa.org/clean_vehicles/trucks_and_buses/page.cfm/pageID=1429), PM and other hydrocarbon emissions within California are responsible for an estimated 3,000 premature deaths , 2,700 cases of bronchitis, and 4,400 hospital admissions, ultimately creating additional healthcare costs totaling $21+billion.

Biodiesel also provides very large reductions in carbon/GHG emissions (85-95% reduction in carbon/GHG for biodiesel made from used cooking oil and distiller's corn oil from ethanol plants) that are critical to meeting LCFS carbon reduction requirements. According to ARB, in Q1/2014 biodiesel provided 18% of all LCFS credits generated.

Thus we strongly urge the ARB to consider the PM, hydrocarbon toxics, and carbon/GHG reductions and associated health benefits when evaluating any ADF regulatory proposal. Additionally, we urge the ARB to consider that the proposed ADF regulations would be in effect during a period when New Technology Diesel Engines (NTDEs, which reduce all tailpipe NOx emissions by 90% regardless of type of fuel) are being phased in due to existing California law.

ADF 7-2

Comments on LCFS Reauthorization and Specific Aspects of the Proposed ADF Regulations

We ask that ARB Members consider the following points as it continues deliberations on LCFS reauthorization and the proposed ADF regulations.

1. LCFS is working as intended – ARB reporting on LCFS credit generation and deficits from 2011 through Q3/2014 shows 9.80 mil MT credits generated and 5.84mil MT in deficits, creating excess credits of 3.96 mil MT. This data is consistent with original ARB staff projections for the rate of credit generation at this point in the program. Clearly the LCFS has created sufficient market signals to attract the necessary volumes of alternative fuels. Our plant in Bakersfield is but one example among many of how LCFS has influenced investment decisions to create alternative fuel production capacity.

LCFS 7-1

2. LCFS carbon reduction timelines – We strongly urge the ARB and its Members to maintain the original LCFS CI reduction at 10% by 2020. We further encourage the ARB to establish stronger compliance curves to continue progress beyond 2020. Maintaining the 10% reduction is 2020 is absolutely critical to send the right market signals to encourage the availability of large volumes of alternative fuels, development of new low carbon fuel technologies, and incentivize significant alternative fuel utilization. Any pushing back of this timeline would send the opposite signal, devalue alt fuel investments made thus far, and discourage future investment. We believe the 10% reduction is fully achievable in 2020. We agree with the findings in the 2/2/15 Promotum report sponsored by the National Resource Defense Council, stating a $100/MT LCFS credit price will incentivize sufficient volumes of alt fuels to be produced and imported into California and reducing CI intensity of petroleum based fuels. Using alternative diesel fuels as a case in point, there is sufficient excess industry-wide production capacity to greatly increase the volumes of biodiesel and renewable diesel

LCFS 7-2

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imported into California (the National Biodiesel Board reports 2.5 bil gal of current U.S. biodiesel production capacity vs actual 2014 domestic production of 1.6 bil gal). — LCFS 7-2 cont.

3. LCFS Program integrity – In line with creating transparent and predictable market rules, ARB should adopt rule proceedings in the event that fraudulent credit trades or other invalid activities are discovered. We would recommend that ARB carefully consider the experience of the US Environmental Protection Agency in its enforcement of the Renewable Fuel Standard (RFS). Delayed prosecutions and a lack of concern for collateral damage caused to good faith market participants undermined respect for the RFS program and the value of RFS credits. We would encourage ARB to insulate good faith market participants from disproportional impacts and to avoid wholesale invalidation of credits. Due to the complex and novel nature of environmental attribute markets, ARB must invest in sufficient resources and personnel to ensure effective enforcement. — LCFS 7-3

4. Impact of ADF Regulations on California Biodiesel Industry – From a California biodiesel producer's perspective the proposed ADF regulations are not ideal for the simple fact that, despite the various economics , emission and health benefits offered by biodiesel, limits will be placed on biodiesel usage in California. However, we do believe that the proposed ADF regulations reflect input from the biodiesel industry and many other stakeholder groups. ARB Staff was really done outstanding job in reaching out to all stakeholders for consistent engagement. As such we feel that the biodiesel usage limits prescribed by the proposed ADF regulations are not unreasonable. They are workable and will achieve the desired goals for NOx management while retaining the ability to meaningfully take advantage of the significant benefits offered by biodiesel blending in California. — ADF 7-3

5. ADF Regulation implementation timeline – The proposed ADF regulations will require significant change within the industry, including new labeling at each retail dispenser and the joint development of new compliance and tracking mechanisms. Other agencies such as the Division of Weights and Measures will require time to adapt their biodiesel related regulations (there may be a need to change the current California labeling requirements at retail dispensers).Thus we believe the implementation timelines as stated in the proposed ADF regulations are reasonable and necessary. — ADF 7-4

6. Mitigation options - We applaud the ARB's understanding that DTBP additive is not an ideal mitigation option for several safety, financial and operational reasons, and thus preserved in the proposed ADF regulations the ability to approve other NOx mitigation additives. We would only add that we hope ARB staff will diligently pursue this in a timely manner in partnership with the biodiesel industry, and consider the use of current commercially available cetane enhancers. — ADF 7-5

7. Accounting for NTDE and Sunset Provisions -. NTDE vehicles which reduce NOx by 90%+ already make up 25%+ of the current heavy duty diesel fleet in California and will grow to 95% by 2023 as required by ARB fleet turnover regulations. In light of this, we believe it is completely reasonable and appropriate that the ADF regulations will sunset when vehicle miles travelled by NTDE heavy duty vehicles reach 90% of the total miles travelled by the California heavy-duty diesel vehicle fleet. — ADF 7-6

We greatly appreciate this opportunity to comment. Please feel free to contact me should you have any questions.

Sincerely yours,

Harry Simpson
President
hsimpson@crimsonrenewable.com
Tel: 720-475-5409

7_OP_ADF_CRE Responses

40. Comment: **ADF 7-1 through ADF 7-3 and ADF 7-5 EA**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

41. Comment: **ADF 7-4**
The comment states that the ADF regulation will require significant change within the industry, including new labeling, and states that the proposed timeframes are "reasonable and necessary."

Agency Response:
Although the proposed regulations do require changes within the industry, new labeling is not required and current labeling requirements are primarily due to federal law. ARB staff set the proposed timeline in response to the infrastructural, logistical, business model, and other changes the biodiesel industry will need to make, in order to comply with the proposal. Staff will monitor the progress of industry's changes and update procedures as necessary.

42. Comment: **ADF 7-6**
The comment states that the sunset provisions for the in-use requirements for biodiesel are reasonable and appropriate.

Agency Response:
ARB staff anticipates that the sunset provision will occur by 2023 based on the current analysis. A program review will be conducted by 2020 and will include a review of the sunset provision timeline.

Comment letter code: 8-OP-ADF-NBB

Commenter: Shelby Neal

Affiliation: National Biodiesel Board

The following letter was submitted to the ADF Docket during the 45-day comment period.

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National Biodiesel Board
1331 Pennsylvania Ave., NW
Washington, DC 20004
(202) 737-8801 *phone*

National Biodiesel Board
605 Cla
Jefferso
(800) 84

17_OP_LCFS
_NBB

8_OP_ADF
_NBB

February 16, 2015

Mary D. Nichols
Chair
California Air Resources Board
P.O. Box 2815
Sacramento, CA 95814
Submitted via electronic mail.

Re: Written comments from the National Biodiesel Board on proposed Regulations for the Commercialization of Alternative Diesel Fuels and a Low Carbon Fuel Standard.

Dear Chair Nichols:

Thank you for the opportunity to comment on these regulations. We sincerely value the job you and all ARB board members and staff undertake in protecting the state's environment and public health.

By way of background, the National Biodiesel Board (NBB) serves as the trade association for the U.S. biodiesel and renewable diesel industries. The NBB represents more than 90 percent of domestic biodiesel and renewable diesel production. In addition to governmental affairs activities, the association coordinates the industry's research and development efforts.

Before delving briefly into a few key regulatory areas, I would like to express our appreciation to the Air Resources Board (ARB) for the cooperation we have received over the past several years. Biodiesel has encountered unique regulatory challenges as a result of the fact that it is the first alternative diesel fuel to ascend to commercial scale. I am pleased to report that, in each situation we have encountered, ARB staff have diligently worked through whatever issues were present with great skill, integrity, and professionalism. It has been a pleasure to work with staff on numerous matters of precedent-setting importance.

LCFS 17-1

Alternative Diesel Fuel Regulation (ADF)

Speaking candidly, and strictly from a practical standpoint, we view NOx mitigation for biodiesel as unnecessary. This view is based on anticipated levels of biodiesel use in the marketplace and air quality modeling studies sponsored by the National Renewable Energy Laboratory and others. These studies show no measurable impacts on ground level ozone from widespread use of B20 due to the fact that small NOx increases are overwhelmed by large decreases in PM and other pollutants.

ADF 8-1

That said, the NBB and its member companies fully support the ADF regulation as drafted. While ARB staff may have chosen a more conservative approach than our industry would have, in a perfect world, preferred, the regulation is clearly underpinned by robust data and technical analysis. Moreover, we view ARB's conservative mindset as appropriate in light of its statutory mission.

ADF 8-2

In the final analysis, the ADF regulation should be viewed as an enhancement to the Low Carbon Fuel Standard (LCFS) because it provides much-needed regulatory certainty for California's biodiesel industry and it identifies a clear, certain, and rational path forward, both for biodiesel and other "new" fuels. Importantly, we also believe the regulation provides strong assurances to stakeholders that use of biodiesel under the LCFS will only result in air quality benefits.

ADF 8-2 cont.

Production and Feedstock Growth

Because of the LCFS, every biodiesel producer in the state is in some phase of expansion, waste feedstock collection rates are higher than they have ever been, and California is developing into a hub for "next generation" feedstock research and development with companies such as REG Life Sciences and Solazyme. These investments by environmental entrepreneurs are being made based on the promise of a stable, long-term GHG reduction policy. For this reason, we support maintaining the 10 percent by 2020 carbon intensity reduction requirement.

LCFS 17-2

Implementation Schedule

After careful analysis, we believe the overarching 10 percent by 2020 objective is workable. Certainly, there can be no question that the diesel requirement is achievable since more than 1.4 billion gallons of biodiesel and renewable diesel have been produced domestically each of the past two years. In light of these fuels' widespread availability and attractive pricing (typically the same as, or less than, petroleum), we see diesel substitutes as a highly attractive early compliance option. In addition, we are bullish on the growth prospects for the California biodiesel and feedstock industries. Continued in-state growth and development will make long-term compliance even easier, even less expensive, and even more beneficial to the state's economy.

LCFS 17-3

Biodiesel Fuel Pathways

We are in general agreement with the technical analysis that underpins the changes in lifecycle assessment for soybean oil, canola oil, and inedible corn oil. Of course, every scientist and stakeholder will, to some extent, have differing views on such inherently complex matters but, on the whole, ARB staff have done a superb job in integrating the most advanced science into these fuel pathways.

LCFS 17-4

Thank you, in advance, for your consideration of our views on these important matters. If I may be of any assistance, please feel free to contact me at any time at (573) 635-3893.

Sincerely,



Shelby Neal
Director of State Governmental Affairs

Cc: California Air Resources Board

8_OP_ADF_NBB Responses

This letter was submitted to the ADF docket as **8_OP_ADF_NBB** and to the LCFS docket as **17_OP_LCFS_NBB**, and appears in the LCFS FSOR. If the comment was related to LCFS, it was labelled LCFS 17-X and if it was related to ADF, it was labelled ADF 8-X.

43. Comment: **LCFS 17-1 through LCFS 17-4**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Final Statement of Reasons under comment letter **17_OP_LCFS_NBB**.

44. Comment: **ADF 8-1 EA**

Agency Response:
The response to this comment is in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

45. Comment: **ADF 8-2**
The comment supports the adoption of the ADF regulation.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF regulation.

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Comment letter code: 9-OP-ADF-AAM

Commenter: Valerie Ughetta

Affiliation: Auto Alliance Manufacturers

The following letter was submitted to the ADF Docket during the 45-day comment period.

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9_OP_ADF
_AAM

AUTO ALLIANCE
DRIVING INNOVATION℠

By Electronic Submission February 13, 2015
Clerk of the Board
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Alliance Comments: Proposed Regulation, Commercialization of Alternative Diesel Fuels

Introduction:

The Alliance of Automobile Manufacturers appreciates this opportunity to comment on the Proposed Regulation on the Commercialization of Alternative Diesel Fuels, including provisions for Biodiesel Blends. The Alliance is an association of 12 car and light truck manufacturers, including BMW Group, Fiat Chrysler Automobiles, Ford Motor Company, General Motors Company, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche Cars North America, Toyota, Volkswagen Group of America and Volvo Cars of North America. The Alliance represents 77% of all car and light truck sales in the United States.

According to CARB's web site, DriveClean, Alliance members are now selling at least 34 different ultra-clean diesel models in the state, including small, sporty, luxury, and pickup trucks.[1] As in many states, California's LDV/MDV diesel market remains relatively small at just over 609,000 total cars, SUVs, pickup trucks, and vans in 2013.[2] Still, this represents growth, and looking forward as automakers develop even more diesel models, the Alliance has every expectation the diesel market here will continue to increase substantially. Therefore our members have a strong interest in this proposed regulation.

The Alliance generally supports this rulemaking for several reasons. First, we agree with the proposal's requirement to have producers of new fuels go through a phased-in process, generate data, and control a new fuel if necessary, before allowing its commercialization. We also appreciate the proposal's attention to OEM interests and the need to protect vehicle performance as a criterion for review and approval. Third, we were glad to see the rule explicitly cross-reference other fuel control requirements, *i.e.*, EPA registration under the Clean Air Act, and California's own fuel quality and pump labeling regulations. Finally, we recognize that new fuels need to be examined for potential impacts on the environment, and in preventing possible adverse impacts the rule will facilitate the introduction of new fuels under the Low Carbon Fuel Standard. The Alliance looks to the LCFS (among other programs) to steer the fuel industry to reduce greenhouse gas emissions from its products, thereby becoming part of the solution for climate change and complementing the efforts of automakers to do the same.

[1] *See* www.driveclean.ca.gov. All of the listed vehicles were made by Alliance members.
[2] Diesel Technology Forum from R.L Polk, May 2014 www.dieselforum.org/diesel-at-work/cars-trucks-and-suvs.

Alliance of Automobile Manufacturers
BMW Group • Fiat Chrysler Automobiles• Ford Motor Company • General Motors Company • Jaguar Land Rover • Mazda • Mercedes-Benz USA • Mitsubishi Motors • Porsche • Toyota • Volkswagen • Volvo
803 7th Street N.W, Suite 300, Washington, DC 20001• Phone 202.326.5500 • Fax 202.326.5567 •
www.autoalliance.org

We present the remainder of our comments in two parts, following the proposed rule's organization. The first part focuses on the rule's generic process for approving any new ADF. The second part focuses on the proposal's application to biodiesel blend use in certain vehicles and engines.

Part 1: The Proposal's Generic 3-Stage ADF Approval Process

A. The Proposal Should More Explicitly Reference Light/Medium-Duty Diesel Vehicles

This regulation appears to have been designed mainly with heavy-duty vehicle and engine impacts in mind. This is understandable, given the current relatively small size of the LDDV/MDDV market in California. As noted above, however, we fully expect this portion of the market to also grow in coming years, and this rulemaking may be the only opportunity to learn about any impacts of new ADFs on these advanced technology vehicles. We suggest making the following changes to the rule.

ADF 9-1

Definition of "Offsetting Factors" (§2293.2(21)(A), page A-9 of ISOR Appendix A):

We suggest adding the underlined words:

"(21) 'Offsetting Factors' means any factors in the commercial market that serve to offset emissions of a pollutant from the use of an ADF. Offsetting factors may include, but are not limited to, the use of:

(A) Specific vehicle technologies such as NTDEs <u>or those used in light or medium duty vehicles</u> that have been proven to reduce emissions of the pollutant; …"

ADF 9-2

Phase-in Requirements Note (§2293.5, page A-12, ISOR Appendix A):

Regarding the header "Note," the Alliance appreciates CARB's attention to vehicle performance issues but suggests the following more detailed modification:

"[Note: … This testing is intended to develop…and identify any <u>light, medium or heavy duty</u> vehicle/engine performance issues such fuels may have.]"

The same modification should be used for consistency at p. A12, Sec. 2293.5(a) Stage I Pilot Program headnote, at p. A16 Sec. 2293.5(a)(3)(D)(4)), and at p. A17 Sec. 2293.5(b) headnote and Sec. 2293.5(b)(3)(A).

ADF 9-3

Stage 1 Application (§2293.5(a)(1), page A-13, ISOR Appendix A):

This section includes a long list of information to be submitted as part of the Stage 1 application to the Executive Officer, but surprisingly, that list does not include any specific information about the types of vehicles/engines to be tested in the pilot program. Test results cannot be properly judged without any details about the test fleet, including with regard to light/medium duty vehicles. We suggest adding:

ADF 9-4

"(B) A description of the test fleet, including information about vehicle brand, model, model year, weight class, emission control technology and other pertinent vehicle/engine details typically included in peer-reviewed studies and an estimate of the maximum number of vehicles or engines involved in the program;"

ADF 9-4 cont.

Stage 2 Application (§2293.5(b)(1), page A-17, ISOR Appendix A):

This section presents a similar concern as under Stage 1; we suggest the following edits:

"(B) An estimate of the maximum number of vehicles or engines involved in this stage along with a description of the test fleet, its emission control technologies, vehicle brand, model, model year, weight class and other pertinent vehicle/engine details typically included in peer-reviewed studies."

ADF 9-5

OEM Approval before Stage 3 (§2293.5(b)(6)(C), page A-21, ISOR Appendix A):

The Alliance appreciates and supports CARB's requirement for OEM approval, but as written, this provision is unclear and can be read to imply exclusion of OEMs of light and mid-duty diesel vehicles (since it refers only to "engine" manufacturers). We suggest this change:

"(C) Obtain approval of at least 75 percent of compression ignition engine original equipment manufacturers and, separately, at least 75 percent of original equipment manufacturers of light or medium duty vehicles with compression ignition engines, depending on the market segment or segments for which the ADF is expected or intended to be used…."

ADF 9-6

B. Other Comments on the Generic ADF Approval Process Portion of the Rulemaking

Stage 1 and Stage 2 Applications (§2293.5(a)(1), pg. A-13; §2293.5(b)(1), pg. A-17); Stage 3A Commercial Sales Subject to In-Use Requirements (§2293.5(c), pg. A-21; Stage 3B Commercial Sales Not Subject to In-use Requirements (§2293.5(d), pg. A-22); and Appropriate Fuel Specifications or In-Use Requirements (§2293(5)(b)(D), page A20). [All pages refer to the ISOR Appendix A]:

The proposed rule is mainly concerned with mis-fueling with regard to increased emissions or other environmental impacts. The Alliance is also concerned, however, about the potential for mis-fueling with regard to adverse vehicle impacts. Some fuels may be incompatible with certain types of vehicles or different generations of the same type of vehicle. For example, most LDDV/MDDVs in the current fleet were not made for greater than B5 blends. This is why automakers have sought pump labels that advise consumers to check their owner's manual or with the manufacturer about the suitability of a particular biodiesel blend for their vehicle. We were very pleased, in fact, when California Department of Food and Agriculture (CFDA) included such language on its biodiesel blend pump labels.

ADF 9-7

Under this proposal, however, compatibility problems may be missed, especially if one segment of the vehicle population is not intended to use the new fuel at all, in which case those vehicles

would not be tested, and their OEMs may not be involved in the approval process. We recommend more explicit attention to this issue to close this gap in the proposed generic portion of the rule.

First, the proposal should require appropriate pump labeling in all stages of the process. The Stage 1 Application already requires the applicant to specify "The manner in which the distribution pumps will be labeled to ensure proper use of the test fuel." *See* §2293.5(a) (1) (F), pg. A-13. We recommend carrying over this provision into Stages 2 and 3, as part of the application and as part of the Executive Order for the conditions of use. Making labeling a universal part of the process at all stages would add an important layer of protection for all vehicles and engines. We urge that such labels refer customers to their owner's manual or manufacturer, to determine whether the fuel is appropriate for their particular vehicle.

Similarly, if appropriate, the generic proposal should explicitly address restriction of distribution by means of specifying the types of fuel pumps required, not just during small scale testing but also during commercialization. For example, if a new fuel is not intended for use in the LDDV/MDDV market segment, the Executive Officer should be prepared to limit distribution of the new fuel to pumps with high flow nozzles. Heavier vehicles and engines are unlikely to use the low flow nozzles because they take too long to fill the larger tanks, and the larger high flow nozzles won't fit in the LDDV/MDDV fuel inlets. Thus, this restriction could be used to protect one market segment without risking mis-fueling by the other. In some circumstances, the opposite, distribution only to low-flow nozzle equipment for LDDV/MDDV, might be warranted.

ADF 9-7 cont.

Public Comment Period, Stage 1Applications (§2293.5(a)(3), page A-15, ISOR Appendix A):

We noted some inconsistencies between the comment periods for Stage 1 and Stage 2. Stage 1 refers to business days while Stage 2 refers to calendar days. This is confusing. The Stage 1 comment period is only 1 week shorter than Stage 2. For simplicity and consistency, we suggest making both periods the same, longer period of 30 calendar days.

ADF 9-8

Part 2: Comments on the Proposal's Application to Biodiesel Blends

Use of Peroxide (DTBP) Additive in Biodiesel (page A-30, Appendix 1 to ISOR Appendix A):

The Alliance shares EMA's concern that this additive could harm vehicle hardware, especially at the high levels this rule requires as an in-use condition. In fact, we suspect the higher concentrations could be relatively more harmful to LDDVs and MDDVs given their smaller size. Thus, we incorporate by reference EMA's comments on this additive into our own comments, and support the remainder of their comments in general. We do recognize that the proposed rule would exempt LDDVs and MDDVs from using biodiesel additized with DTBP. Requiring DTBP in any portion of the fuel supply, however, will increase the risk of the additized fuel entering the smaller vehicles, whether intentionally or accidentally. This may be true even where the fuel producer demonstrates secure/centralized refueling.

ADF 9-9

Prevention of Accidental Mis-fueling in LDDVs/MDDVs: If CARB nonetheless decides to retain the DTBP requirement, the Alliance urges CARB to prohibit its use in pumps using low flow nozzles for LDV/MDVV, as discussed above. This prohibition would protect light and medium duty vehicles without risking mis-fueling (with un-additized biodiesel) by the heavier portion of the diesel market for which this in-use control is intended.

ADF 9-9 cont.

Incorporation of Biodiesel Blend ASTM fuel quality standards (p. A-26, Sec. 2293.7(a) (2) :

Alliance members support reliance upon the ASTM fuel specifications as incorporated by the California Department of Food and Agriculture (CDFA).

ADF 9-10

*F**uel Pump Labeling (§2293.7(a)(2), page A-26, ISOR Appendix A, incorporation by reference to CDFA biodiesel regulations contained in CCR, Title 4, Div. 9, Chapter 7, section 4202)***:

Again, the Alliance commends CDFA for previously adopting a state biodiesel blend label that directs consumers to check their owner's manual or with their engine manufacturer, and we support CARB explicitly including this cross reference to this labeling regulation (in addition to CDFA's fuel quality specification) in this proposal. This label will become increasingly important as the light/medium duty diesel vehicle population grows in California and nationwide, as a variety of different biodiesel blends and other alternatives emerge in the market.

ADF 9-11

***

We thank the California Air Resources Board and staff for attention to our concerns. Please feel free to contact Valerie Ughetta, Alliance Director for Automotive Fuels, at (202) 326 5549 or at vughetta@autoalliance.org should you have any questions about these comments.

9_OP_ADF_AAM Responses

46. Comment: **ADF 9-1**
The comment suggests that the ADF proposal should more explicitly reference light- and medium-duty diesel vehicles to ensure that impacts on the light duty vehicles are considered for new ADFs.

Agency Response: ARB staff considered light- and medium-duty diesel vehicles as well as off-road and heavy duty on-road engines and vehicles when designing the provisions of the proposal. The proposed ADF regulation consists of two parts: 1) A three-stage process for all ADFs to be introduced into the California market and, 2) In-use requirements for biodiesel as the first ADF. The biodiesel portion considers light and medium duty vehicles, allowing exemptions for fleets consisting of 90% or more light- or medium-duty vehicles. This exemption acknowledges the lack of concern for NOx for those vehicles and that the concern lies with the use of biodiesel in heavy duty legacy vehicles. It is important to understand that biodiesel in-use requirements are applicable for biodiesel only, and would not necessarily be applicable to all ADFs. Additionally, each ADF may have different in-use requirements or exemptions.

47. Comment: **ADF 9-2**
The comment requests changes to the definition of “offsetting factors” to include use in light- or medium-duty vehicles.

Agency Response:
The definition of “Offsetting factors” is written to serve all ADFs. The comment requests that the item discussing vehicle technology specifically mention light- and medium- duty vehicles. The current definition of offsetting factors includes vehicle technology and although NTDEs are listed as an example it is not necessary to include all vehicle technologies examples. Additionally, the definition of offsetting factors acknowledges that the list is not comprehensive since the language already states ‘Offsetting factors may include, *but are not limited* to, the use of’.

48. Comment: **ADF 9-3**
The comment suggests additional regulatory language to include a reference to light-, medium-, or heavy-duty engines in a note regarding performance testing intent. .

Agency Response:
The language in section 2293.5 is written to encompass all ADFs and impacts of those ADFs on all engines. The referenced text mentions vehicle and engine performance issues. Specifically calling out light-,

medium-, or heavy-duty engines does not enhance or clarify the section, since all engines are included.

49. Comment: **ADF 9-4**
The comment suggested additional regulatory language regarding information about engines and vehicles to be tested be submitted in a Stage 1 application.

Agency Response:
In light of the comment, ARB staff clarified the requirement in Section 2293.5(a)(1), as part of 15-day changes. Staff revised part of the Stage 1 application to include testing vehicle/engine information.

50. Comment: **ADF 9-5**
The comment suggested additional regulatory language regarding information about engines and vehicles to be tested be submitted in a Stage 2 application.

Agency Response:
In light of the comment, ARB staff clarified the requirement Section 2293.5(b)(1), as part of 15-day changes. Staff revised part of the Stage 2 application to include testing vehicle/engine information. Additionally, information submitted as part of the Stage 1 application process is carried over into the Stage 2 application process. Any changes or updates to the information submitted for Stage 1 must be included in the Stage 2 application.

51. Comment: **ADF 9-6**
The comment suggests additional regulatory language to specifically address light-and medium-duty original equipment manufacturer (OEM) approval prior to Stage 3.

Agency Response:
Please see the paragraph regarding 75 percent threshold in response **ADF 1-2**, and the paragraph regarding light-, medium- or heavy-duty vehicles in response **ADF 9-3**.

52. Comment: **ADF 9-7**
The comment expresses concerns about potential misfueling of vehicles due to improper pump labeling as a result of the ADF proposal.

Agency Response:
ARB staff agrees with the comment on the issue of pump labeling in Stage 1 and 2 and has responded to this by expanding and clarifying the Stage 1 pump labeling requirements as part of the 15-day changes.

Please see the paragraph regarding misfueling in response **ADF 1-3** for additional information on the updated labeling requirements.

53. Comment: **ADF 9-8**
The comment points out inconsistencies with the comment periods associated with Stage 1 and Stage 2.

Agency Response:
ARB staff clarified this requirement as part of the 15-day changes. Timeframes are now consistently expressed as business days. Additionally, 15-day changes were made so that both the Stage 1 and 2 public review periods are now 30 business days.

54. Comment: **ADF 9-9**
The comment expresses concern that about use of DTBP as an additive may harm vehicle hardware, echoing comments from the truck and engine manufacturer association. Additionally, they suggest prohibiting the use in pumps with low-flow nozzles.

Agency Response:
Please see the paragraph regarding the study and use of DTBP in response **ADF 1-6**.

Regarding the suggestion to prohibit the use of DTBP in pumps using low flow nozzles for light- and medium-duty vehicles: DTBP is already accepted for use up to EPA levels in light- and medium-duty trucks, for purposes other than NOx mitigation, therefore staff believes that banning the additive would be disruptive to those other programs. However, staff will continue to work with the commenter to further examine the issue. DTBP misfueling, is addressed in the paragraph regarding misfueling, in response **ADF 1-3.**

55. Comment: **ADF 9-10**
The comment supports the reliance on ASTM fuel specifications.

Agency Response: ARB staff notes the comment.

56. Comment: **ADF 9-11**
The comment supports the reference to the California Department of Food and Agriculture biodiesel blend label.

Agency Response:
ARB staff appreciates the supportive comment and agrees that it is important to have clear labeling requirements in the ADF regulation as a variety of alternative fuels and fuel blends emerge in the market.

Comment letter code: 10-OP-ADF-TEMA

Commenter: Roger Gault

Affiliation: Truck and Engine Manufacturers Assoc.

The following letter was submitted to the ADF Docket during the 45-day comment period.

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STATE OF CALIFORNIA
AIR RESOURCES BOARD

Proposed Regulation on the Commercialization of New Alternative Diesel Fuels	)	Agenda Item: 15-2-3
	)	Board Hearing: February 19, 2015

COMMENTS OF THE TRUCK AND ENGINE MANUFACTURERS ASSOCIATION

Roger Gault
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STATE OF CALIFORNIA
AIR RESOURCES BOARD

Proposed Regulation on the Commercialization of New Alternative Diesel Fuels	)	**Agenda Item: 15-2-3**
	)	**Board Hearing: February 19, 2015**

COMMENTS OF THE TRUCK AND ENGINE MANUFACTURERS ASSOCIATION

On January 2, 2015, the California Air Resources Board ("ARB") published a "Notice of Public Hearing to Consider the Proposed Regulation on the Commercialization of New Alternative Diesel Fuels" [CCR, Title 13, Chapter 5, Article 3, Sub article 2, Sections 2290, 2291, and 2293] (the "Proposal").

The Truck and Engine Manufacturers Association ("EMA") is the international trade association that represents the interests of the world's leading manufacturers of compression ignition engines used in both on-highway and nonroad products that will utilize the fuels covered by the Proposal.

I. Background

EMA has actively participated in the testing program and regulatory development process that has led to the Proposal concerning the use of biodiesel blends, renewable diesel fuels, and gas-to-liquid (GTL) fuels.

At the outset of the rulemaking process, and throughout the testing program, EMA and its members emphasized to ARB the importance of ensuring that any alternative fuel regulations recognize the fundamental importance of fuels to the performance, durability, and exhaust emission levels of both new and existing products. In short, fuels cannot exist independent of the engines that use them any more than engines can exist without the fuels required to power them.

The ARB test program designed to evaluate biodiesel blendstocks from various feedstocks, renewable diesel fuels, and GTL fuels is by far the most comprehensive study of the effects of fuel properties on exhaust emissions ever conducted. Even so, the test program evaluated only a small sub-set of alternative diesel fuels on a relatively small segment of the broad population of engines, vehicles/equipment, and emission control systems that make up the diverse inventory in California.

ADF 10-1

While the Proposal includes several features important to evaluating whether an alternative fuel is appropriate for use in the marketplace, it also raises a significant number of concerns. Our observations follow.

II. Impact of the Proposal

Although the Proposal would not directly regulate the activities of engine manufacturers, several aspects of its implementation will require engine manufacturer participation. For example, for a new alternative fuel to move from Stage 2 to either Stage 3A or 3B, the fuel supplier must "obtain approval of at least 75% of compression ignition engine original equipment manufacturers for which the ADF is expected or intended to be used." That implies that engine manufacturers must have had sufficient opportunity to evaluate the proposed new fuel, or fuel blending component, to assess acceptability in both new and existing engines in the California marketplace. The Proposal does not set forth a process for determining how to meet the 75% threshold or whether it has been met. Engine manufacturers are in favor of having the regulation call for their acceptance of new fuels, but are concerned that there will be little or no enforcement without an ARB approval process. Therefore, EMA recommends that the Proposal be revised to require written acceptance of a new alternative diesel fuel meeting the required consensus standard by engine manufacturers representing 75% by number and 75% by engines in service for those manufacturers certifying engines with ARB for sale in California.

Even if the Proposal were revised to clarify the level of engine manufacturer acceptance required, EMA still has significant concerns regarding misfueling by the 25% of manufacturers and/or engines that have not accepted the use of the alternative fuel. In addition, engine manufacturers are concerned that the use of alternative fuels will impact engines' ability to demonstrate compliance with in-use emission requirements and on-board diagnostic requirements given the potential disparity in fuel properties between alternative fuels and California petroleum diesel fuel. The lack of any long-term emission influence evaluation of alternative fuels, either during the rulemaking development or as a requirement of the Proposal, raises significant concerns.

ADF 10

Given the 5-year maximum total timeframe outlined for Stage 2, it is not reasonable to assume that engine manufacturers will have sufficient time to complete the evaluations necessary after they have determined that a new fuel is viable. Similarly, it is not realistic for a new fuel to "achieve adoption of all consensus standards applicable to the ADF" within the prescribed timeframe. A review of the timeline associated with development of the ASTM D6751 standard for biodiesel and its inclusion at up to the B5 level in D975 would be beneficial as a guideline for the time necessary to complete the required consensus standards and engine manufacturer approvals. It also may be instructive to note that ARB's October 2011 report on biodiesel, renewable diesel, and GTL fuels was five years in the making. Both of those examples demonstrate that the requirements for completion of Stage 2 will require more time than currently proposed. Engine manufacturers also are concerned that the Stage 2 requirement to develop a "consensus standard" for the alternative fuel may be misconstrued to mean a narrow consensus among fuel providers rather than the necessary broader consensus among engine manufacturers, users, and regulators in addition to fuel providers. As a result EMA recommends that Stage 2 be expanded to a maximum of 10 years.

ADF 10-3

In declaring that B6-B20 blends are at Stage 3A, ARB apparently deems conventional biodiesel methyl ester meeting D6751 and blended at B6-B20 levels as having met Stage 2 requirements. While a number of engine manufacturers have approved B20 for use in some of their engines, it is not clear that the 75% approval threshold, however defined, has been achieved. As noted above, there are substantial questions concerning how ARB intended the 75% approval threshold to be achieved. The apparent ARB approval of B20 blends raises significant questions concerning both how this determination was made, and what regulatory action ARB intends to

ADF 10-4

undertake to prevent misfueling using B20 blends in engines that have not been accepted for B20 use by the engine manufacturer.

ADF 10-4 cont.

In addition, it appears that ARB has determined that conventional biodiesel methyl esters meeting D6751 can be blended at levels greater than B20 without meeting the following Stage 2 requirements: (i) achieve adoption of a consensus standard applicable to the ADF; (ii) obtain approval of at least 75% of compression-ignition-engine original equipment manufacturers; (iii) identify appropriate fuel specifications for the ADF; and (iv) identify appropriate mitigation strategies for the ADF, none of which have been achieved. Additionally, the apparent approval of biodiesel blends greater than B20 conflicts with ARB's stated purpose in the Proposal to "foster the introduction and use of innovative ADFs in California that have no significant adverse impacts overall on public health or the environment relative to conventional, petroleum-based CARB diesel." ARB's own testing program demonstrated a significant increase in NOx emissions from compression-ignition engines utilizing biodiesel blends greater than B20. Additionally, ARB's NOx mitigation test program (utilized to identify options for NOx mitigation for biodiesel blends less than B20) did not identify any means to mitigate NOx emissions from blends greater than B20. ARB's flawed assumption seems particularly illogical given that ARB is implementing a voluntary low-NOx emission program for heavy-duty engines concurrent with this rulemaking which requires significant NOx reductions from those evaluated in the biodiesel/renewable diesel test program related to the ADF rulemaking.

ADF 10-5

ARB also has deemed all non-ester renewable diesel fuels, gas-to-liquid fuels, and Fisher-Tropsch fuels as "Diesel Substitute" by definition — meaning that those fuels can be utilized without further study by ARB, engine manufacturers, or California consumers. Without definition of the fuels and/or their fuel properties, engine manufacturers have significant concerns associated with untested fuels being placed in the California marketplace. ARB does propose a definition for "non-ester renewable diesel", but the proposed definition is inadequate because it does not define the fuels evaluated by ARB to determine acceptance. ARB also proposes properties for what is termed "Reference CARB Diesel" in Appendix A Table A.9, but has not proposed any requirement that the prescribed properties be utilized to define the minimum requirements for the non-ester renewable diesel fuels, gas-to-liquid fuels, and Fisher-Tropsch fuels deemed diesel substitute fuels. Recent experience has demonstrated that this loophole may be utilized to allow marketing of sub-standard products. In addition, engine manufacturers do not have sufficient experience with fuels meeting ARB's Diesel Substitute fuel definition to accept their use without constraint. While market factors may be expected to preclude significant use of those fuels neat, or at very high (greater than 75%) blend levels, neither ARB nor engine manufacturers have conducted any testing to demonstrate that such fuels could be used without significant engine performance or regulatory compliance concerns. Engine manufacturers recommend that the definition of "Diesel Substitute" be revised to clarify that: "'Diesel Substitute' includes, but is not limited to, blends of no more than 75% non-ester renewable diesel, gas-to-liquid fuels, Fischer-Tropsch fuels; …" and that the definition of non-ester renewable diesel be revised to "Non-ester Hydrocarbon Renewable Diesel".

ADF 10-6

ARB has proposed the use of a minimum of 0.75 percent Di-tert-butyl peroxide (DTBP) in biodiesel blends of B10 to B15 and the use of a minimum of 1.0 percent Di-tert-butyl peroxide (DTBP) in biodiesel blends of B15 to B20 when the biodiesel utilized is "low saturation," as one option for an acceptable biodiesel NOx mitigation measure (reference Appendix 1(a)(1)(A)). Engine manufacturers have significant concerns associated with this option for NOx mitigation. Specifically, peroxides such as DTBP are known to reduce oxidation stability of fuels. Neither

ADF 10-7

ARB nor the fuels industry has demonstrated that the proposed final B10 –B15 and/or B15 - B20 blends would comply with the ASTM D7467 requirement for oxidation stability, or that use of sufficient anti-oxidant additive to meet the D7467 requirements would result in a final fuel that either mitigates NOx emission increases or is viable for engines in the marketplace. Moreover, the fuel industry has advised that it would not recommend the use of these options to mitigate NOx emissions from biodiesel blends. ARB's inclusion of such options effectively proclaims it a viable fuel option without the testing and approvals required to pass from Stage 2 to Stage 3 for other ADFs in the future.

ADF 10-7 cont.

III. Recommendations

ARB should make several changes to the Proposal prior to its adoption as a Final Rule.

Specifically, EMA recommends that ARB:

1. Prescribe that the Stage 2 time period be a minimum of 2 years, with the opportunity to renew every 2 years for a total of 10 years.
2. Establish, in writing, a process that ARB will utilize to determine that 75% of engine manufacturers have accepted a Stage 2 fuel.
3. Define the term "consensus standard" in the Final Rule to clarify that at a minimum, consensus standards required by the regulation are developed by fuel producers, fuel marketers, engine manufacturers, and users.

ADF 10-2 cont.

4. Direct the California Division of Weights and Measures to develop and implement regulations that mitigate the potential for misfueling as part of the transition from Stage 2 to Stage 3A or 3B, including, among other things, regulations associated with the use of B6-B20 blends deemed by ARB to be in Stage 3A that have not been accepted for use in all engines in California.

ADF 10-4 cont.

5. Clarify that all biodiesel blends greater than B20 are Stage 1 fuels that must meet all of the Stage 1 and Stage 2 program requirements prior to determination if Stage 3A or 3B is appropriate for those fuels.

ADF 10-8

6. Revise the definition of "Diesel Substitute" to prevent blends of greater than 75% non-ester renewable diesel, gas-to-liquid fuels, Fischer-Tropsch fuels from being used prior to acceptance by engine manufacturers.
7. Revise the definition of "Non-ester Renewable Diesel" to "Non-ester Hydrocarbon Renewable Diesel."

ADF 10-9

8. Delete the option to utilize a 0.75% percent DTBP additive treatment in B10-B15 biodiesel blends and the option to utilize 1.0 percent DTBP additive treatment in B15 - B20 biodiesel blends utilizing low saturation biodiesel NOx mitigation measure.

ADF 10-7 cont.

If you have any questions about EMA's comments, or would like to discuss this matter further, please do not hesitate to contact us.

Respectfully submitted,

Truck and Engine Manufacturers Association

10_OP_ADF_TEMA Responses

57. Comment: **ADF 10-1**
The comment states that the ARB test program tested only a small sub-set of ADFs on a small segment of the engine population, engines/equipment, and emission control systems operating in California.

Agency Response:
Since it would be not be feasible or cost-effective to test every variety of engine, vehicle, and emission control system, ARB used a standard scientific approach for acquiring a representative sampling of information. For this testing program, ARB focused on biodiesel fuel blend emissions to make its determination. ARB staff believes the sampling contained in the foundational work is scientifically sound and roubust enough to understand the possible risks and benefits associated with alternative diesel fuel use and to make regulatory decisions based on that understanding. Additional testing will be conducted, if necessary, for new ADFs as they progress through the multi-stage process.

58. Comment: **ADF 10-2**
The comment expresses concerns regarding the portions of the ADF regulation that may require participation from engine manufactures, specifically with regard to the requirement that an ADF receives approval from 75 percent of the OEMs for which the ADF will be used and the potential for misfueling. Additionally, the comment makes recommendations for expanding the Stage 2 timeframe, establishing a process for determining the 75 percent threshold and defining consensus standards.

Agency Response:
These issues were addressed in prior comment responses. Please refer to the paragraph regarding 75 percent threshold in response **ADF 1-2**, and the paragraphs in response **ADF 1-3**, regarding misfueling, in-use requirements, 5-year timeframe for Stage 2, consensus standards and long term emissions testing.

59. Comment: **ADF 10-3**
The comment expresses concerns regarding the five-year timeframe of Stage 2 being a reasonable amount of time for engine manufactures to complete their evaluations of new ADFs and to achieve consensus standards.

Agency Response:
These issues were addressed in prior comment responses. Please refer to the paragraphs in response **ADF 1-3**, regarding 5-year timeframe for Stage 2 and consensus standards.

60. Comment: **ADF 10-4**
The comment raises concerns regarding whether conventional biodiesel methyl ester blended as B6-B20 has met all the Stage 2 requirements, specifically the 75 percent approval threshold.

Agency Response:
Please see response **ADF 1-3**, paragraphs regarding misfueling and 75 percent threshold for biodiesel. This response also contains a reference to response **ADF 1-2**, regarding 75 percent threshold.

61. Comment: **ADF 10-5**
The comment raises concerns whether the ADF proposal allows for conventional biodiesel to be blended above B20.

Agency Response:
This issue was addressed in a prior comment. Please see response **ADF 1-4**, paragraphs regarding B10 maximum and Exceptions (B20). Additionally, ARB staff made 15-day changes to the title of section 2293.6(a) to clarify that the Stage 3A in-use provisions are only applicable to biodiesel blends of B20 or below.

62. Comment: **ADF 10-6**
The comment recommends a change to the "diesel substitute" definition.

Agency Response:
Please see response **ADF 1-5**, regarding the removal of the term "diesel substitute."

63. Comment: **ADF 10-7**
The comment raises concerns with the use of DTBP as a NOx mitigation option in the ADF proposal.

Agency Response:
Please see the paragraph regarding the study and use of DTBP in response **ADF 1-6**.

64. Comment: **ADF 10-8**
The comment requests ARB staff clarify that biodiesel blends above B20 are considered Stage 1 fuels.

Agency Response:
ARB staff made 15-day changes to the title of section 2293.6(a) to clarify that the Stage 3A in-use provisions are only applicable to biodiesel blends of B20 or below. ASTM D6751 is the Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels; however, this is a fuel *blendstock* specification not a fuel

specification. The blendstock meeting the ASTM6751 may be blended in with CARB diesel at any level however, the proposed ADF regulation does not allow use of biodiesel blend greater than B20. Biodiesel blends above B20 must undergo the multi-staged evaluation process to comply with the ADF regulation.

65. Comment: **ADF 10-9**
The comment recommends changes to the "diesel substitute" and "non-ester renewable diesel" definitions.

Agency Response:
Please see response **ADF 1-5**, regarding the term "diesel substitute." This response also contains a reference to consensus standards, appearing in response **ADF1-2**.

Additionally, ARB staff agrees with the recommendation on renewable diesel and added clarification to the regulation as part of the 15-day changes. Staff removed the term *"non-ester renewable diesel"* from section 2293.2 and replaced it with "*renewable hydrocarbon diesel.*" .

Comment letter code: 11-OP-ADF-IWP

Commenter: Curtis Wright

Affiliation: Imperial Western Products

The following letter was submitted to the ADF Docket during the 45-day comment period.

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_IWP

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11_OP_ADF
_IWP

Imperial Western Products, Inc.

February 16, 2015

Mary D. Nichols
Chair
California Air Resources Board
1001 I Street
PO Box 2815
Sacramento, CA 95812

RE: Proposed Adoption of a Regulation Governing the Commercialization of Motor Vehicle Alternative Diesel Fuels; Proposed Re-Adoption of an Updated Low Carbon Fuel Standard

Dear Ms. Nichols,

Imperial Western Products (IWP) is a biodiesel producer located in Coachella, California. We have been producing biodiesel continuously since 2001, and have made over 54 million gallons of biodiesel. Almost all of the biodiesel we make is made from used cooking oil collected throughout California, and the fuel we sell is sold back into the same areas. In the early years of our biodiesel production, we had to rely on specialty markets, where people who wanted to use biodiesel were willing to go to great lengths to buy it. This resulted in uneven demand, and our business had many wild swings in profitability. We would increase production, then slow production. We would hire and then lay off workers.

Upon the introduction of the federal Renewable Fuel Standard (RFS), and California's Low Carbon Fuel Standard (LCFS), we began to see more and more interest from larger, established fuel providers. These programs, especially the LCFS, resulted in more widespread blending of biodiesel into diesel at the fuel terminals in California, which resulted in steady demand for our biodiesel. Of the 54 million gallons of biodiesel we have made, 30 million gallons have been made since 2011. This demand has allowed us to hire more workers, and keep production steady throughout the year. We currently employ 30 workers directly in the biodiesel production plant. These jobs are good paying manufacturing jobs located in an area where these jobs are scarce. Many of our employees worked in temporary agriculture jobs, or in service jobs in the Coachella valley prior to coming to IWP. In addition to the workers who are employed directly in the biodiesel production plant, we have dozens of employees who work in our used cooking oil collection business. These workers are located throughout the state.

LCFS 31-1

I would like to point out three back stories of some of our employees. Lee Munoz grew up in Coachella, and was working for a television satellite dish installer when we hired

P.O. Box 1110
Coachella, CA 92236
(760) 398-0815
(760) 398-3515

him to work in the biodiesel plant in 2002. Lee began to learn about biodiesel production, became a shift supervisor, and is now Production Manager overseeing 22 plant operators.

Danny Chiang was also raised in the Coachella valley. A mechanical engineer and graduate of UC Berkeley, he was working in a clothing store in Rancho Mirage when we hired him in 2011. Danny quickly learned about biodiesel production, and oversaw installation of a plant-wide control system. Danny programmed all of the plant control system, and not only supervised installation, but actually did a lot of the wiring himself. Danny is now lead plant engineer and supervises another engineer.

Eduardo Zepeda grew up in Coachella and attended the University of California Riverside and studied mechanical engineering. One of his professors, Dr. Wayne Miller, would bring his chemical engineering class to our plant every year on a field trip. I called Dr. Miller in the spring of 2012 and asked him if he had any students who would be interested in a summer internship. He allowed me to post a message to his students, and Eddie responded and was hired. After graduating, we hired him full time. He is now learning the biodiesel production process and has successfully completed several projects, including a water treatment and disposal system.

These are just three of the success stories in our biodiesel plant, and all are possible because of steady demand for biodiesel in California. The LCFS has added value to blending biodiesel in California, and when it gets back on track it will provide additional stability to the market which will allow our company to plan for the future, and continue to provide good paying jobs.

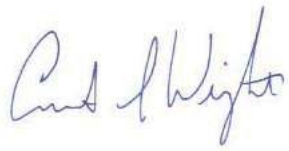
LCFS 31-2

With LCFS back on track, the Alternative Diesel Fuel (ADF) regulations will provide a framework for biodiesel to be blended and prevent any adverse emission impacts until the fleet turnover of new technology diesel engines is achieved. It is important to us that the ADF regulations have a clearly defined sunset, when 90% of the miles travelled are done by new technology diesel engines, and that this end point is reviewed annually so that as soon as this milestone is reached, limits on biodiesel blending are removed. With this provision, hopefully LCFS reductions won't be hindered. We feel strongly that biodiesel, California's advanced biofuel, will be important in helping reach LCFS goals.

ADF 11-1

IWP has been making biodiesel in the Coachella valley since 2001, and with re-adoption of LCFS and implementation of ADF we are confident we can continue to increase biodiesel production to displace petroleum, lower greenhouse gasses, lower criteria air pollutants, and provide jobs in California.

Sincerely,



Curtis Wright

11_OP_ADF_IWP Responses

This letter was submitted to the ADF docket as **11_OP_ADF_IWP** and to the LCFS docket as **31_OP_LCFS_IWP**, and appears in the LCFS FSOR. If the comment was related to LCFS, it was labelled LCFS 31-X and if it was related to ADF, it was labelled ADF 11-X.

66. Comment: **LCFS 31-1 and LCFS 31-2**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **31_OP_LCFS_IWP**.

67. Comment: **ADF 11-1**

Agency Response:
The response to this comment is in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

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Comment letter code: 12-OP-ADF-CBA

Commenter: Celia DuBose

Affiliation: California Biodiesel Alliance

The following letter was submitted to the ADF Docket during the 45-day comment period.

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12_OP_ADF
_CBA

February 17, 2015

Mary D. Nichols
Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95812

RE: **SUPPORT FOR LCFS READOPTION AND ADF REGULATION ADOPTION** at February 19-20, California Air Resources Board Hearing

Dear Chair Nichols:

Please accept these brief comments from the California Biodiesel Alliance (CBA) in support of both the readoption of the Low Carbon Fuel Standard (LCFS) and the adoption of the Alternative Diesel Fuel (ADF) regulation. CBA is California's not-for-profit biodiesel industry trade association, representing over 50 businesses and stakeholders, including all of the state's biodiesel producers. CBA strives to increase awareness about biodiesel as California's leading and widely available advanced biofuel that delivers significant economic, environmental, and energy diversity benefits throughout the state.

We submit these comments as part of a unified statement from the biodiesel industry, and specifically support the comments of the National Biodiesel Board (NBB) on both program areas, including the technical issues related to ARB's updating of the carbon intensities for biofuels.

First, we wish to thank your California Air Resources Board (ARB) staff for their diligent and inclusive process of seeking and incorporating public comments and specifically for working with our industry over many years as we have endeavored to assure accuracy for biodiesel pathways under LCFS and to finally achieve full legal acceptance for biodiesel. We very much appreciate staff's extraordinary investment of resources and expertise in implementing state law, including California's notable progress in reaching its goals under AB 32, while working to provide the critically needed stable regulatory environment required by the investor community.

In our previous comments on the LCFS, CBA has supported key ARB proposals, including for the Compliance Curve and the Price Cap, and have weighed in on the details of the abundant supply of biodiesel available to help reach program targets. Our industry is happy to have generated a steadily increasing percentage of LCFS credits, up to 13% in Q3 2014. We value our ability to make this contribution to the success of LCFS as the world looks to California for solutions to the dire realities of climate change.

In urging your adoption of the ADF regulation, we wish to express our appreciation for the framework that allows biodiesel to move forward with some time to develop a new NOx mitigation additive and for the exemptions for light and medium duty fleets and for those with 90% NTDEs. We support the 2019 review that will provide for data on actual vehicle miles traveled as fleets turnover to the use of NTDEs. CBA looks forward to continued discussions with ARB staff on ways to address the concerns of some of our member companies, as expressed in their written comments, and to the adoption of the best possible final ADF regulation.

ADF 12-1

We appreciated Richard Corey's recent reference to the state's reliance on biodiesel for "future reductions of toxic diesel particulate matter" in his presentation at the California Biodiesel Conference on February 4th in Sacramento. Our industry will continue to bring that and other of biodiesel's many benefits to California, especially to communities that are economically disadvantaged and suffer disproportionately from diesel emissions-related diseases.

Thank you again for your leadership. We applaud your success and look forward to working with you going forward.

Sincerely,

Curtis Wright
Chairman
California Biodiesel Alliance

Cc: California Air Resources Board

12_OP_ADF_CBA Responses

68. Comment: **ADF 12-1**
The comment supports the adoption of the ADF regulation.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF regulation.

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Comment letter code: 13-OP-ADF-WSPA

Commenter: Cathy Reheis-Boyd

Affiliation: Western States Petroleum Assoc.

The following letter was submitted to the ADF Docket during the 45-day comment period.

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13_OP_ADF
_WSPA

Western States Petroleum Association
Credible Solutions • Responsive Service • Since 1907

Catherine H. Reheis-Boyd
President

February 17, 2015

Clerk of the Board, Air Resources Board,
1001 I Street,
Sacramento, CA 95814
http://www.arb.ca.gov/lispub/comm/bclist.php

Re: **Public Hearing to Consider the Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Board Agenda Item 15-2-3**

The Western States Petroleum Association (WSPA) appreciates the opportunity to submit written comments for the record on the above proposed rulemaking. WSPA is a non-profit trade association representing twenty-five companies that explore for, produce, refine, transport and market petroleum, petroleum products, natural gas and other energy supplies in California, and four other western states.

WSPA has worked extensively with ARB over the past few years on this alternative diesel regulation, and believes the approach outlined in the proposed regulation is the best based on the large number of issues and considerations.

Although we do not believe the petroleum industry should be responsible for mitigating the NOx increases of biodiesel through the means of potentially problematic additives or reformulating base diesel formulations, and we question whether the mitigation options indicated in the regulation are realistic in practice, we are prepared to work with staff as implementation issues arise in the coming years.

Sincerely,



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cathy@wspa.org ▪ www.wspa.org

c.c. ARB Board Members – arbboard@arb.ca.gov
Virgil Welch – vwelch@arb.ca.gov
Richard Corey – rcorey@arb.ca.gov
Jack Kitowski – jkitowsk@arb.ca.gov
Samuel Wade – swade@arb.ca.gov
Elizabeth Scheehle – escheehl@arb.ca.gov
Jim Aguila – jaguila@arb.ca.gov
Lex Mitchell – amitchel@arb.ca.gov

Western States Petroleum Association Comments on CARB's Notice of Public Hearing to Consider the Proposed Regulation on the Commercialization of Alternative Diesel Fuels – February 19th, 2015 Board Hearing

The Western States Petroleum Association (WSPA) appreciates the opportunity to submit written comments for the record on the above proposed rulemaking. WSPA is a non-profit trade association representing twenty-five companies that explore for, produce, refine, transport and market petroleum, petroleum products, natural gas and other energy supplies in California, and four other western states.

We understand that at the February 19-20 ARB Board Hearing, the Board will consider re-adoption of the Low Carbon Fuel Standard (LCFS) Regulation as well as adoption of the Alternative Diesel Fuel (ADF) Regulation. We also understand that staff has jointly progressed these two rulemakings and considers them intimately connected as a joint regulatory action "package" to address Court requirements emanating from the July 15, 2013 State of California Court of Appeal, Fifth Appellate District (Court) opinion in POET LLC *v.* California Air Resources Board (2013) 218 Cal.App.4th 661. The judge's opinion was that ARB did not adequately address biodiesel NOx emissions that could potentially result from LCFS implementation. The ADF regulation represents staff's proposed solution to address California Environmental Quality Act deficiencies associated with biodiesel NOx impacts. WSPA is providing separate comments on the two concurrent rulemakings and we regret the unavoidable overlap that is likely to occur within our respective comment submissions.

WSPA has worked with ARB over the past few years on this alternative diesel regulation and believes the approach outlined in the proposed regulation is the best based on the large number of issues and considerations. We are prepared to discuss our comments further with ARB staff, if needed.

Key Points / Highlights

WSPA's key comments are summarized below. More detailed discussion on individual sub-topics is provided in the balance of our submission:

- **CEQA** - WSPA strongly believes combining the ADF and LCFS processes into one CEQA "project" is not procedurally appropriate, and will result in an insufficient environmental analysis. ARB should analyze the LCFS and the ADF as two separate projects. At the very least, ARB must acknowledge the possibility that the two regulations will not be adopted or implemented concurrently, and should rework the Draft EA to clarify the impacts from each of the regulations, and the specific mitigation measures applicable to each. **ADF 13-1**

  Furthermore, the alternatives analysis presented by the Draft EA is woefully insufficient when it comes to the ADF. In essence, the Draft EA only analyzes a complete, as-is adoption of the ADF and a "no project" alternative for the ADF, **ADF 13-2**

without analyzing any other of the potentially feasible scenarios, such as adoption of a different type of ADF regulation. The Draft EA offers no explanation as to why alternatives to the ADF were not analyzed. CEQA does not permit such an oversight.

ADF 13-2 cont.

- **Regulatory Approach** - WSPA believes ARB has appropriately determined the set points (pollutant control levels) for biodiesel blends in the state comprehending both seasonal requirements and biodiesel quality considerations. WSPA supports ARB's approach which comprehends the contribution of in use-requirements such as New Technology Diesel Engine (NTDE) market penetration and Renewable Diesel use. We believe staff reviewed all available engine testing data and, while we remain skeptical of the strength in the data at low biodiesel blend levels (B5), we concur that higher level biodiesel blends would result in NOx emission increases in the legacy fleet, if left unmitigated.

- **Sunset** - WSPA supports ARB's decision to sunset the program when the percentage of Vehicle Miles Travelled (VMT) by NTDE heavy duty vehicles reaches 90% of the total VMT by heavy duty diesel trucks. We agree that emissions control technology featured in newer heavy duty engines obviates the need for further/continued biodiesel blend NOx mitigation controls.

- **Two-Year Lead Time** - WSPA recommends ARB reconsider its proposal to provide a two-year lead time for affected stakeholders to prepare for mitigation of higher level biodiesel blends as such preparations, in our opinion, will likely require a minimum of three years.

ADF 13-3

- **Interim Program Reviews** - WSPA recommends ARB incorporate additional interim program reviews in the ADF regulation and align the schedule for such reviews with any corresponding interim program reviews or staff reports stipulated in the LCFS. We recommend a minimum of two reviews for both programs by 2020, and prefer annual staff reports to the Board to assess the health of the programs. We presume staff will be monitoring the status/progress of both programs closely and believe annual staff reports to the Board will help identify any elements needing program changes, as well as any market condition issues necessitating accelerated agency response.

ADF 13-4

- **DTBP** - We do not believe ARB has conducted a thorough assessment of the NOx reduction additive (di-term-butyl- peroxide – DTBP) which is included as a NOx mitigation measure in the ADF regulation. We recommend staff fully re-examine the use of DTBP for a purpose other than it was originally intended (which was cetane enhancement) and at levels substantially higher than the parts per million range that is recommended for use in other applications. We also recommend ARB check on notification requirements with EPA relative to requiring a PMN (Pre-manufacturing notification) or other documentation for materials being used for other than their intended purpose. Impacts to be evaluated should include, but not be limited to, the following:

ADF 13-5

- Full multimedia evaluation of environmental impacts (e.g. fate and transport and non-combustion air emissions),
- Toxicological impacts,
- Safety impacts (e.g. peroxide stability and interactions with other additives such as anti-oxidants), and,
- Materials compatibility impacts (e.g. OEM approval, metallurgical compatibility in distribution storage, piping, and fueling equipment).

ADF 13-5 cont.

Detailed Comments

1. Satisfying CEQA

A. Combining into One Project:

Combining the ADF and LCFS processes into one CEQA "project" is not procedurally appropriate, and results in an insufficient environmental analysis. ARB should analyze the LCFS and the ADF as two separate projects. At the very least, ARB must acknowledge the possibility that the two regulations will not pass concurrently, and should revise the Draft EA to clarify the impacts from each of the regulations, and the specific mitigation measures applicable to each.

The Draft EA published by ARB is the environmental document for both the LCFS and the ADF regulations. While these two rulemakings are being developed concurrently, they are also being treated as two separate processes. Because the two regulations are subject to two separate rulemakings, there is the possibility that one regulation could pass but the other could not, or that one regulation could be challenged and its implementation delayed while the other continues to move forward.

ADF 13-6

ARB has cited CEQA Guidelines §15378(a) in support of its approach to combine environmental review of the two regulations into one CEQA "project." However, section 15378(a) of the Guidelines simply states that a "project" is "the whole of an action, which has a potential for resulting in either a direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment…" While section 15378(c) of the Guidelines clarifies that a "project" can include an activity that requires more than one discretionary approval by one or multiple government agencies, the Guidelines nowhere provide for a "project" that encompasses two separate activities that happen to be related to one another, but are not interdependent. *See* CEQA Guidelines §15378(c).

Interdependence, an element lacking here, is key to including separate actions under the umbrella of one CEQA "project" for purposes of environmental review. *Tuolumne County Citizens for Responsible Growth, Inc. v. City of Sonora* (2007) 155 Cal.App.4th 1214, 1230-1231 [finding a road realignment and construction of a shopping center were part of the same "project" because the shopping center's opening was legally dependent upon the road's realignment]. The LCFS and

ADF 13-7

ADF regulations certainly pertain to related subject matter, but they are not legally dependent upon one another—the LCFS can exist without the ADF (and indeed has in the past), and vice versa.

Both statute and regulation recognize the need to analyze separate "projects" in circumstances similar to these. For example, while a real estate developer may request a rezoning of property, as well as a tentative subdivision map, for purposes of effectuating development, those two related but separate actions are recognized as distinct "projects." *See El Dorado Union High School Dist. v. City of Placerville* (1983) 144 Cal.App.3d 123, 129-130; CEQA Guidelines §15037. Just as with the two related but distinct rulemakings here, each of these two legal actions, which may very well impact the same development, nonetheless may occur without the other and in completely separate processes, and may produce significantly different impacts.

ADF 13-7 cont.

Simply put, CEQA does not allow ARB to take two different activities which each have different impacts and require different analyses and pass them off as one "project" to streamline its environmental review process. The process that ARB has adopted here makes it impossible to separate out which impacts stem from the LCFS regulations and which from the ADF regulations, <u>even though the two rules are being considered in separate rulemakings, have distinct impacts as a practical matter, and may not both be adopted, or may be adopted on different schedules</u>.

ADF 13-8

CEQA requires that environmental review documents be "written in a manner that will be meaningful and useful to decision makers and to the public." Cal. Pub. Res. Code §21003(b); *see Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal.3d 376, 392. When neither decision makers nor the public can meaningfully understand the impacts that will arise from each proposal and available mitigation, the usefulness of the Draft EA as a valuable decision-making tool is significantly undermined, contravening the intent of CEQA.

ADF 13-9

B. <u>Inadequate Alternatives Addressed:</u>

The Draft EA also fails to adequately analyze alternatives. Under CEQA, an environmental review document "must consider a reasonable range of alternatives to the project" and must "make an in-depth discussion of those alternatives identified as at least potentially feasible." *See Preservation Action Council v. City of San Jose* (2006) 141 Cal.App.4th 1336, 1350; *Sierra Club v. County of Napa* (2004) 121 Cal.App.4th 1490. The purpose of such an analysis is to allow informed decision making, and the onus for analyzing a sufficient range of alternatives falls squarely on the agency. *Laurel Heights Improvement Assn. v. Regents of University of California* (1988) 47 Cal.3d 376, 405.

ADF 13-10

But ARB's Draft EA falls far short of this requirement. The Draft EA only analyzes a "no project" alternative—LCFS regulations being set aside as a result of the *POET* decision and no adoption of the ADF; a second alternative—re-

ADF 13-11

adopting the existing LCFS without any of the proposed updates and adopting the ADF regulation as proposed; and finally, a "Gasoline-Only Compliance Curve" alternative—an alternative that would remove the diesel standard from the LCFS so that the compliance curves apply only to gasoline and gasoline substitute fuels. Despite the Draft EA's statement that it presents a fourth action alternative—the "No Trading Case Alternative" –ARB never includes a description of that alternative in the Draft EA.

ADF 13-11 cont.

ADF 13-12

Additionally, ARB's description of the alternatives is somewhat misleading. The alternatives that ARB discusses are more accurately described as: (1) no LCFS and no ADF; (2) re-adoption of the existing LCFS and adoption of the proposed ADF as-is; and (3) the "Gasoline-Only Compliance Curve Alternative," which, like the first alternative, would not adopt the proposed ADF, or any rule on alternative diesel fuels. There is no analysis of an alternative that would involve re-adoption of the proposed LCFS with a different ADF regulation. In contravention of CEQA, this analysis overlooks potentially less impactful options. *See Citizens of Goleta Valley v. Board of Supervisors* (1990) 53 Cal.3d 553, 566.

ADF 13-13

The mere three alternatives presented by the Draft EA insufficiently represent the broad scope of alternatives, and fail to take into account clearly feasible scenarios—such as an ADF regulation that is substantively different from the one proposed by ARB. In fact, the Draft EA analyzes no alternatives beyond a "no project" alternative for ADF: either the ADF is not adopted at all, or it is adopted exactly as is. ARB cannot limit the alternatives analysis on the ADF without explaining "in meaningful detail" the basis for its conclusion that there are no feasible alternatives to the ADF as proposed. *Laurel Heights Improvement Assn.*, 47 Cal.3d at 405.

ADF 13-14

CEQA requires the Draft EA explore more alternatives than the three presented here. ARB has provided an insufficient "alternatives analysis" in connection with these rulemakings, and therefore the Draft EA should be revised accordingly.

ADF 13-15

2. Program Dates & Timetables

A. Start Date and Timeline:

WSPA appreciates and supports ARB's apparent effort to provide lead time for affected parties (biodiesel producers and blenders) to implement the necessary capital facility modifications to enable the biodiesel blend NOx mitigation that will be required to enable higher level biodiesel blending in the future. We also recognize that staff acknowledges the relationship between ADF and LCFS program requirements and the fact that, directionally, increased LCFS CI reduction requirements as we approach 2020 will drive the need for higher levels of biodiesel in the CA marketplace.

Our industry will likely not be called upon to provide the lion's share of the facilities necessary to mitigate higher level biodiesel blends as this task will be far greater for biofuel producers. However, we are concerned about the potential

ADF 13-3 cont.

availability and cost of pre-mitigated biodiesel by 2018 and question whether the lead time provided is sufficient (approximately 2 years if the regulation is adopted in 2015 and goes into effect in 2016).

We disagree with staff's statement that a two year lead time is consistent with "established CARB policy" which, in our experience, has been a minimum of three years and oftentimes four years, depending on the degree of complexity of the preparations required. Staff has recognized the need for additional logistical capabilities (additive storage and injection facilities to address the safety and environmental risks poses by DTBP) to be put in place, the need for additional changes by fleet operators focusing on exempted NTDE or light-duty diesel fleets, and the lead time required for testing and certification of alternative formulations comprehending higher biodiesel blend levels. Recognizing that all these are valid concerns, WSPA recommends staff reexamine their two year proposal to complete preparations, as it seems unduly optimistic given current construction and permitting timetables (and lead times) necessary in California, and the typical three year timeframe required to prepare for and conduct a successful alternative diesel formulation certification engine test program.

ADF 13-3 cont.

B. Sunset Date:

WSPA supports staff's proposal to set a program "sunset date" and to have that date comprehend the degree of market penetration of NTDEs in the California heavy duty diesel market. We expect staff will examine and further refine the in-use requirements and market outlook during interim program reviews/reports to the Board. In conducting such reviews we believe staff should examine the net NOx impact of the relevant factors (e.g., degree of Low Saturation B5 blending, renewable diesel use and NTDE VMT market share) in determining whether the proposed sunset can be advanced. We note the projections of Table 4.1 include significant NOx reductions starting in 2018 and recommend that staff consider sunsetting the program as early as possible, provided that doing so results in no projected NOx increase.

ADF 13-16

WSPA also recommends that staff define the particulars/specifics of how the program sunset will be implemented by affected stakeholders, including better definition of how staff plans to advise our industry that the program will be sunsetting (i.e., Guidance document, Board Action, etc.) and how much time staff envisions will transpire between when the time analyses indicate the sunset trigger has been met, and the time industry can actually implement the associated changes. Obviously, we would prefer to more fully understand the pathway and hope that it includes clear provisions for quick action by staff when the time arrives.

C. Interim Program Reviews:

As noted above, WSPA recognizes that staff, under Par. 2293.6(6) plans a program review of biodiesel in-use requirements by 12/31/2019 to determine their efficacy

ADF 13-4 cont.

and, in doing so, staff will consider the effects of offsetting factors that impact NOx emissions. We support staff's proposal to do so, but feel that the schedule of interim program reviews and staff reports to the Board on the ADF program needs to be aligned with that proposed for the LCFS program as the two are related.

The LCFS ISOR document proposes an interim review by 1/1/2019 which is not in line with the ADF program review. Furthermore, as indicated in our WSPA LCFS comments, we feel that the single targeted program review for the LCFS is insufficient and would come too late to materially impact our 2020 LCFS compliance burden. To this end, we are recommending that annual program reviews and staff reports to the Board be incorporated in both regulations.

ADF 13-4 cont.

3. <u>Appropriateness of "Set-points" or Triggers for Mitigation</u>

WSPA has worked closely with ARB over the past two years in reviewing the available emissions data from engine test programs on ARB biodiesel blends. We examined programs where both ARB diesel was used as the base fuel, and programs where diesel fuel "approaching ARB properties" was used in an effort to get around the obvious difficulties of insufficient data in certain blend ranges (e.g. B0-B5). Several different engine test programs involving different engines and test protocols further complicated staff's difficult task. We appreciate the difficulty staff had in arriving at the appropriate pollutant control levels when faced with data mostly concentrated around B0, B5 and B20 and little in between. We offered to assist in providing technical oversight in the design and execution of the most recent technical program at UC-Riverside. WSPA members shared proprietary engine emissions data in an effort to ensure that ARB's decisions were based on the best available data.

WSPA recognized early on that the potential success of staff's proposal to implement a novel regulatory approach in the ADF where NOx (and/or other air pollutant impacts) resulting from use of biodiesel blends in California would require mitigation upon meeting a pollutant control trigger level was largely dependent on staff's ability to appropriately determine those set points based on the available data. We also recognized the in-use requirements for biodiesel blends would have to be flexible enough to not impede fuel blenders' ability to rely on this important renewable blendstock to meet the Carbon Intensity reduction goals of the LCFS program.

ADF 13-17

We believe staff has taken the time to understand our technical input and recognize the final proposal includes the aspects of in-use NOx mitigation impact on NTDEs, market penetration of renewable diesel, and the difference in NOx-forming tendency between Low and High Saturation biodiesel.

A quick review of WSPA feedback provided in 2013 when staff first introduced this novel regulatory approach indicates that the fundamental principles we put forward as being essential for the ADF regulation's success have been largely fulfilled:

- The proposal has been kept relatively simple:
  - The proposed biodiesel blend control levels are on a per-gallon basis.
  - The proposed biodiesel blend control levels apply state-wide
  - Staff proposes dual trigger controls based on seasonality and biodiesel saturation level.
- The proposal includes biodiesel blend mitigation trigger levels that will remain unchanged throughout the duration of the program.
- The proposal comprehends the offsetting in-use mitigation effects of such as NTDE introduction (i.e., fleet turnover) and renewable diesel market penetration.
- There is appropriate balance between the reporting and record-keeping requirements for both biodiesel producers and biodiesel blenders and distributors. We remain hopeful that as the regulation moves into the implementation phase, we can work with staff to recognize potential synergies in these areas with the existing recordkeeping and reporting requirements associated with the LCFS.
- Staff has made it clear that program duration is finite and tied to market penetration of advanced-emission controlled heavy duty diesel engines such as those featured in 2010 and newer trucks.

ADF 13-17 cont.

WSPA's primary difference of opinion with staff's analysis in support of setting the biodiesel mitigation threshold levels included in the proposed rulemaking, involves the degree of certainty presented by staff in the existence of a statistically significant NOx increase (of approximately 1%) for Low Saturation biodiesel at the B5 level. We find staff's conclusions to be more reflective of the selection of studies chosen for inclusion in the analysis, and their choice of statistical methodology, rather than a true reflection of a definitive trend established by a strong underlying database. Despite the additional "data points" generated by the most recent UC-Riverside study, the available data at the B5 level remains rather limited.

Nevertheless, while WSPA remains unconvinced that the perceived NOx increase at the B5 level is real, WSPA also recognizes that staff is not proposing additional NOx mitigation controls for B5 blends (beyond the offsetting impacts of NTDE and renewable diesel market penetration). WSPA agrees with staff that the NOx increase is statistically significant in the B10-B20 range and supports the overall proposed mitigation threshold structure pivoting on biodiesel degree of saturation and seasonal seasonality.

4. **<u>Workability of Mitigation Options</u>**

A. <u>GTL:</u>

There is no indication that GTL is still a mitigation option. WSPA requests that GTL be clearly identified as a mitigation option.

ADF 13-18

B. <u>Evaluation of DTBP:</u>

ADF 13-5 cont.

WSPA is concerned that adequate Multi-Media Evaluation (MME) has not been performed with regard to the use of di-tertiary butyl peroxide (DTBP) at the concentrations currently required for mitigation in the proposed Alternative Diesel Fuel (ADF) regulations.

A review of the "STAFF REPORT - Multimedia Evaluation of Biodiesel" dated November 2013, only includes an evaluation of combustion air emissions impact (i.e. NOx reduction) due to the use of the DTBP additive. The report does not include an evaluation of the following impacts associated with use of DTBP as a biodiesel blend additive:

- Release Scenarios
- Biodiesel Production, Storage, Distribution, and Use
- Biodiesel Toxicity
- Transport and Fate
- Waste generation and waste management

Because ARB is setting the blend level of DTBP as part of the proposed regulation, and given the recommended blend levels of DTBP in the proposed ADF rule are at least an order of magnitude greater than typical CARB diesel additives, we feel ARB should fully evaluate the potential impacts of the proposed formulation, including but not limited to:

- Toxicity of ADF approved blends
- Soil, surface water, and ground water
- Diesel storage equipment
- Additive storage and blending equipment
- Equipment used in the transport and dispensing of diesel fuel
- Motor vehicles using diesel fuel (including a review with Original Equipment Manufacturers).
- Air emissions impacts related to non-combustion diesel fuel activities (e.g. transport and storage)

In addition, a review of MSDS for DTBP from two manufacturers[1, 2] indicate there are specific issues regarding DTBP that are not discussed in ARB's MME. We feel the MME should include an evaluation of the DTBP specific issues listed below prior to approving the use of DTBP at the recommended concentrations:

- DTBP decomposes at approximately 80^{o}C; recommended maximum storage temperature 40^{o}C[1, 2]
- Flash point of 6^{o}C, highly flammable at room temperature[1, 2];
- Precautions are needed to guard against electrostatic discharge [1, 2]
- Control of vapor space, such as nitrogen blanketing, may be required or recommended [2]

ADF 13-5 cont.

[1]United Initiators MSDS for DTBP from: http://www.united-initiators.com/products/details/di-tert-butyl-peroxide/
[2] Azko Nobel TRIGONOX B MSDS from: https://www.akzonobel.com/polymer/msds/

- Segregation of DTBP from accelerators, stabilizers, acids, bases, and heavy metals is highly recommended[1, 2]
- Use only stainless steel 316, polypropylene, polyethylene, or glass lined equipment for storage[2]
- Must avoid contact with rust, iron and copper[2]

ADF 13-5 cont.

We note the Tier I, Tier II, and Tier III MME reports all concluded that the impact of priority or widely used additives would need further evaluation (see excerpted references in Appendix 1 attached).

C. Certification of Alternative Diesel Fuel Formulations

WSPA supports staff's proposal to allow the certification of alternative diesel fuels resulting in emissions equivalence with diesel under Subarticle 3, Appendix 1, Par (a)(2), however we have the following questions and comments:

- As outlined elsewhere in our comments, two years is not a realistic timetable for planning, undertaking and completing such testing. Staff should comprehend that such testing is typically an iterative process; it is likely that initial testing of any candidate will fail and will need to be fine-tuned based on the results of the failed initial attempt before the next engine test is initiated. This can oftentimes be repeated several times before a successful outcome is obtained.

ADF 13-3 cont.

- In our experience, the cost of such a program can easily run in the $2-3 million range per successful formula certification, reflecting pre-certification scoping quality testing as well as a number of engine test repeats as outlined above.

ADF 13-19

- We are puzzled by staff's decision (Appendix 1, Par (a)(2)(A)) to not allow applicants the flexibility of using any ARB certified alternative diesel formulation as the reference fuel for the certification of a higher biodiesel content formulation. ARB's own testing in assessing the NOx impact of biodiesel blends at UC-Riverside was conducted using a reference fuel that was representative of typical in-use CARB diesel. Insisting that the 10% aromatics (Table A9) content test fuel be employed for this purpose ignores the fact that there is no such fuel currently on the market and that all existing alternative formulations have already been tested (and passed) against such a reference fuel. It stands to reason that, if a B20 alternative formulation candidate yields equivalent NOx emissions against an in-use alternate CARB diesel formula, and if that same alternate CARB diesel formula yielded equivalent NOx emissions to the reference 10% aromatics fuel, then the B20 formulation should be deemed to result in no NOx increase over the reference fuel.

ADF 13-20

- Staff describes the required biodiesel additive certification fuel under Appendix 1, Par (a)(2)(D) as a "virgin soybean oil" material. This is inconsistent with staff's effort throughout the remainder of the ISOR to consistently distinguish among biodiesel alternatives by saturation level and not feedstock source. We recommend that it be changed in this section accordingly. In the same Paragraph we note Table A.8 which reports the targeted range of properties of the biodiesel candidate fuel, the unadditized cetane number of which is listed as 47-50. We have several comments on this requirement:

    - For formulas involving higher levels of Low Saturation biodiesel, there should be no minimum cetane number specified, as a lower cetane number would only reflect a more difficult to mitigate biodiesel. If an applicant has access to such a material and can successfully mitigate its NOx impact, why shouldn't they be allowed to perform the necessary testing to do so? The applicant should always have the ability to self-specify a narrower cetane number range in their particular application.
    - For formulas involving higher levels of Low Saturation biodiesel, the maximum cetane number should be lower than the 56 cetane number cut-off between Low Saturation and High Saturation biodiesel - less an allowance to reflect ASTM test reproducibility at that CN level. This is necessary to ensure that no High Saturation biodiesel can be used in the certification testing. The corresponding certification should stipulate that it is applicable to biodiesel quality reflecting the material that was tested.
    - For formulas involving higher levels of High Saturation biodiesel, the maximum cetane number should be no lower than the 56 cetane number cut-off between Low Saturation and High Saturation biodiesel plus an allowance to reflect ASTM test reproducibility at that CN level. This is necessary to ensure that the lowest quality High Saturation biodiesel would yield no NOx increase and thus the corresponding certification would be applicable to all High Saturation biodiesel. The applicant should always have the ability to self-specify a narrower cetane number range in their particular application, i.e., a higher minimum High Saturation biodiesel cetane number.

ADF 13-21

- We find the language in Appendix 1 (a)(2)(G)(2) unduly vague and extremely difficult (if not impossible) to comply with. We recommend it be struck from the proposed ADF regulation language. If ARB continues to include such language in the ADF rules we would urge staff to address our concerns (outlined below), such that testing requirements must be clearly defined and implementable. Furthermore, in defining the technical specifics of these requirements, we request that ARB involve impacted stakeholders in the selection of appropriate tests and procedures.

ADF 13-22

Our concerns (previously submitted to ARB in December 2014) regarding the lack of specificity in the rule language related to toxicity testing, include:

- The methods to be used for cellular testing are not defined. A variety of test designs is available for each of the cellular-level effects tests, but few of them are standardized and the results may not be comparable among the various tests for a given effect:
  - The rule should clearly define tests, toxicity endpoints, and methods related to cellular testing.
  - The rule should specify the number of samples, treatments, and replicates to be evaluated.
  - The specified tests, protocols, and sample sizes should account for natural variability in cellular level response and sample composition.
  - Impacted stakeholders should have adequate time to provide input into and comment on any such proposal.
- The rule should specify the means of generating and collecting the particulate exhaust sample(s).
- The rule should include a defined procedure for conducting exposures to the PM in a consistent, representative manner.
- The rule should specify that both PM exposure procedures and cellular testing must be conducted by qualified laboratories with rigorous QA/QC procedures.

In the absence of any defined methodology on toxicity testing, each applicant required to perform testing can choose a different test design(s), which will result in an accumulation of data for multiple formulations, amongst which comparison can't readily be made. We emphasize that key to ensuring appropriate comparisons is the number of samples, treatments, and replicates to be evaluated. These parameters must be considered and specified in the ADF regulation requirements.

ADF 13-22 cont.

5. <u>Recordkeeping and Reporting</u>

WSPA appreciates and supports ARB's apparent effort to keep the reporting and recordkeeping requirements for biodiesel under the ADF relatively simple and focused primarily on biodiesel producers/importers that are likely to have more responsibilities, particularly regarding the potential NOx mitigation of their product. The burden on blenders, distributors, and retailers should be minimized as much as possible for both the recordkeeping and reporting obligations, focusing primarily on being able to identify/reconcile the volumes and type of B99/B100 bought and the disposition of those volumes in various biodiesel blends. Associated records (invoices, PTD's, etc.) with the appropriate information on the volume/type of NOx control employed, should round out the program tracking segment of the regulation and provide adequate assurance that the control levels

listed in Table A.1 and the in-use requirements listed Appendix 1 are performing satisfactorily.

Although the intent in this area is as described above (and consistent with information presented throughout the ADF workshops leading to the proposed regulation), the actual regulatory language is not adequately defined. We are concerned that the requirements (as described) are vague such that they could potentially be read to include unnecessarily burdensome provisions on our industry.

ADF 13-23

Below we offer some areas where additional clarity would be helpful regarding the requirements in the recordkeeping and reporting segment of the regulation (Paragraphs 2293.6 and 2293.8):

- We would like clarification of whether the biodiesel reporting requirements outlined in Par. 2293.8 (b) apply to fuel blenders. Par. 2293.6(a)(1) states: *"Starting January 1, 2016, any person who produces, imports, blends, sells or offers for sale or supply any biodiesel, shall be subject to the reporting requirement of Stage 3A, pursuant to Par. 2293.8(b)."*

  The biodiesel definition outlined in Par. 2293.2 applies to B99/B100 only. There is a separate definition for biodiesel blends in this Paragraph and staff has not explicitly included "biodiesel blends" in the above text, implying that it only applies to producers/importers. However, Par. 2293.8(b)(2) (A) appears contradictory in that it seems to comprehend ADF blenders:

  "Each report shall include… the volume of ADF and ADF blend offered, supplied or sold during each month."

ADF 13-24

- Similarly, we would like clarification as to whether the pollutant control level requirements outlined in Par. 2293.6(a)(2) apply to fuel blenders. Par. 2293.6(a)(1) states:

  "Starting January 1, 2018, any person who produces, imports, blends, sells or offers for sale or supply any biodiesel, shall be subject to pollutant control levels under Subsection (a)(2) of this Section."

  Once again, the biodiesel definition outlined in Par. 2293.2 applies to B99/B100 only. There is a separate definition for biodiesel blends in this Paragraph and staff has not explicitly included "biodiesel blends," potentially implying that the requirement only applies to producers/importers. However, Par. 2293.6(a)(2) appears contradictory in that it seems to comprehend blenders:

  "Biodiesel blends above the pollutant control level for NOx emissions are required to employ one of the in-use requirements for biodiesel listed in Appendix 1."

ADF 13-25

The logical interpretation would be that biodiesel blenders would be affected by this provision only if they are engaging in mitigation activities themselves. It would be helpful to have staff confirm that this is their intention.

ADF 13-25 cont.

- If staff intended for the above requirements to apply to producers of biodiesel blends, our industry would have to report test "results of a specified number of representative samples" and the "volume/quantity of the applicable in-use requirements" indicated in Par. 2293.8(b)(2)(B), (C) and (D).

  It is understandable that biodiesel producers/importers would have the responsibility for performing the necessary testing at an appropriate frequency to ensure that their product is appropriately classified in the product transfer notification statements they provide the oil industry (e.g., Low Saturation versus High Saturation, NOx mitigated versus Non-Mitigated). It is also understandable that biodiesel/producers would have to report on the nature of mitigation employed and any associated/pertinent in-use requirement data.

  It is not intuitively clear, however, why blenders would be required to perform such testing, i.e., why can't blenders rely on the notification statements from producers/importers on what the precise characteristics of the biodiesel are and consequently how they need to manage their biodiesel blending operations? Once again, we believe staff should clarify that these requirements would only apply to a blender, if that blender were to be engaged in mitigating the B100/B99 they receive to producing biodiesel blends requiring mitigation per Par. 2293.6(a)(2). Biodiesel blenders not producing blends requiring mitigation and simply adhering to the volumetric maxima of Par. 2293.6(a)(2), or purchasing pre-mitigated biodiesel, should be excluded from the reporting requirements of Par. 2293.8(b)(2)(B), Par. 2293.8(b)(2)(C) and 2293.8(b)(2)(D). For those blenders, a monthly volumetric reconciliation of purchased volumes of B99/B100 against the disposition of those volumes in the various biodiesel blends produced should suffice.

ADF 13-26

- Staff should clarify the requirement in Par. 2293.8(c)(4)(C) to include a statement on invoices indicating NOx control for each biodiesel blend transaction applies only if mitigation is employed consistent with the provisions of Appendix 1, either by the blender themselves or by the blender's biodiesel provider (pre-mitigated).

ADF 13-27

6. Appendices

Appendix A: Proposed Regulation

- On page 27 of Appendix A, it states the proposed regulation requires more information for a Stage 3B (no mitigation required) submission than on p. 22. What is the purpose of providing results of a specified number of representative samples for an ADF that has no emissions impact?

ADF 13-28

Appendix D: Draft Environmental Analysis

- In the ADF background, it states that ADFs are not hydrocarbons. This is not accurate unless ARB is going to say that all renewable diesel sources are not ADFs and also should be exempt from the ADF regulation completely. **ADF 13-29**

- On page 25, ARB staff mentions the use of a biodiesel cetane index whereas in fact none exists. There should be language stating that this is in development for potential future use in the regulation or deleted from the text. **ADF 13-30**

Appendix E: Summary of DOF Comments to the Combined LCFS/ADF SRIA and ARB Responses

- On page 18, ARB is attributing PM, HC and CO emission reduction benefits from increased biodiesel to the LCFS. The section does not show how staff will apportion the emissions, but WSPA would like to reinforce the fact the ULSD/DPF combo is responsible for a vast majority of the reduction to be seen between now and 2020, all of which has been in force prior to the LCFS program. **ADF 13-31**

Appendix G: Supplemental Statistical Analysis

- In the summary, it mentions there is no statistical difference between B5 soy and B10 Animal. However, it does NOT mention that there is a statistical difference between B5 soy and B5 Animal as well as B10 soy versus B10 Animal. The staff's report needs to give Animal biodiesel equal treatment in the write up. **ADF 13-32**

7. **Additional Technical Comments**

- On page 25 of the ISOR, in the SWRCB regulation section, ARB mentions that B5 has undergone UL certification. It is important to include the fact that fuels above B6 have not undergone independent certification and there is no current activity to obtain certification. As such, B6-B20 blends of biodiesel are generally stored above ground. ARB's ISOR also makes no mention of the UST status of renewable diesel as expressed by the joint SWRCB/ARB statement saying that Renewable diesel should be treated the same as CARB Diesel. **ADF 13-33**
  http://industries.ul.com/wp-content/uploads/sites/2/2015/01/B5_Biodiesel.pdf
  http://www.arb.ca.gov/fuels/lcfs/20130731arbwaterboardjointstatementrd.pdf

- In the ISOR on page 41, in the NOx Emissions Data Analysis section, ARB mentions that B5-soy is 1% higher NOx than CARB Diesel and is highly statistically significant; B10-soy is 2% higher; B5-animal is not statistically different; and B10 animal is not statistically different from CARB Diesel. However, in Appendix G it was stated that B5-soy and B10 Animal **ADF 13-34**

were statistically no different. There is evidently a conflict between the ISOR and Appendix G that needs correcting.

ADF 13-34 cont.

- Chapter 7, Air Quality and Environmental Justice in the ISOR – p. 50: WSPA notes in the discussion of emission reductions, that the introduction of biodiesel only provides PM, HC and air toxic benefits for legacy, pre-2007 vehicles. For 2007 and later vehicles, these benefits would have been realized with or without biodiesel in the market. The benefit should not be lumped into the biodiesel benefit side.

ADF 13-35

- On page 52, it states biodiesel provides short-term PM, HC and air toxics benefits due to legacy vehicles. Long-term benefit would already be realized by the fleet turnover to NTDEs that was in motion prior to the biodiesel regulation, so ARB needs to revise its claims.

ADF 13-36

- On page 9 of the ADF15 Notice, under benefits, it states "*Premature deaths caused by ultra-fine particles are expected to decrease by 90 per cent in 2020 due to biodiesel and renewable diesel replacing petroleum diesel*." This statement should not be included as a benefit because the vehicle fleet turnover would reduce ultra-fine particles with or without biodiesel or renewable diesel. The contribution benefit lies solely with the ULSD/DPF combo and should not be attributed to biodiesel or renewable diesel.

ADF 13-37

8. <u>Previous 2013 ADF Postponed Hearing - WSPA Comments that are still relevant</u>

- **<u>2293.2 Definitions</u>**

Changes to definitions should be made as follows:

<u>Biodiesel Blend</u>

A biodiesel blend may consist of biodiesel blended with petroleum based diesel, renewable diesel, GTL, and/or other Fischer-Tropsch fuels. Therefore, the term "petroleum based" within the definition of "Biodiesel Blend" should be replaced with the broader term "CARB diesel" as follows:

ADF 13-38

"Biodiesel Blend" means biodiesel blended with ~~petroleum based~~ ***<u>CARB</u>*** *diesel fuel."*

We assume CARB diesel includes GTL, renewable diesel, etc.

<u>"Diesel Substitute"</u>

"Diesel Substitute" is a circular term as defined in the proposed regulation, because renewable diesel is both CARB diesel and under this definition a "Diesel Substitute". We believe the term "Low Emission Diesel" or something similar conveys ARB's intent better than the term "Diesel Substitute". "Diesel

ADF 13-39

Substitute" should be replaced with this updated term throughout the proposed regulation and have the following definition:

*"~~Diesel Substitute~~ **Low Emission Diesel**" means ~~any liquid fuel that is intended for use with CARB diesel or CARB diesel blends in a compression ignition engine~~ **a type of CARB diesel fuel that can reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel**. "~~Diesel substitute~~ **Low Emission Diesel**" includes, but is not limited to, renewable diesel; gas-to-liquid fuels; Fischer-Tropsch fuels; CARB diesel blended with additives specifically formulated to reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel; and CARB diesel specifically formulated to reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel."*

ADF 13-39 cont.

"Hydrocarbon"

The definition of "Hydrocarbon" is as follows:

"Hydrocarbon means any chemical mixture that is composed solely of hydrogen and carbon."

This definition ignores the fact that hydrocarbon mixtures, although of an elemental composition consisting primarily of carbon and hydrogen, also contain sulfur, oxygen or nitrogen from residual impurities and contaminants (excluding added oxygenated materials). To avoid potential confusion, we recommend ARB instead adopt the definition used in ASTM D975 for "hydrocarbon oil" as the definition for "hydrocarbon" in the ADF regulation as follows:

*Hydrocarbon means ~~any chemical mixture that is composed solely of hydrogen and carbon~~. **a homogeneous mixture or solution with elemental composition primarily of carbon and hydrogen and also containing sulfur, oxygen and/or nitrogen from residual impurities and contaminants and excluding added oxygenated materials.***

ADF 13-40

- **Section 2293.3 Exemptions**

Paragraph 2293.3 (b) exempting CARB diesel from the ADF regulation states CARB diesel blends are comprised solely of CARB diesel and one or more diesel additives that comprise "in the aggregate" no more than 1.0 percent by volume of the CARB diesel blend. EPA limits additives in diesel fuel to 1 percent individually per 40 CFR80.521(b)(1) . We believe ARB should do the same for consistency. Therefore, section 2293.3 (b) should be modified as follows:

*"CARB diesel blends comprised solely of CARB diesel and one or more diesel additives **individually** comprising ~~in the aggregate~~ no more than 1.0 percent by volume of the CARB diesel blend. This provision does not apply to additives used pursuant to the in-use requirements specified in Appendix 1;"*

ADF 13-41

40CFR80.521 is accessible via the Electronic Code of Federal Regulations at:

http://www.ecfr.gov/cgi-bin/text-idx?SID=ca97c6c0579783920cb5aab1e3ae3def&node=40:17.0.1.1.9.9.63.11&rgn=div8

ADF 13-41 cont.

- **Section 2293.4 General Requirements Applicable to All ADFs**

  ARB made no changes addressing previous WSPA comments that Part (b) of this paragraph indicates an ADF must meet all of DMS' regulatory requirements/standards. We can foresee a possible problem whereby the two agencies (ARB and DMS) adopt current ASTM versions at different times – thereby making it difficult if not impossible to comply with both versions for a period of time.

ADF 13-42

- **Section 2293.5 (d) Commercial Sales Not Subject to In-Use Requirements**

  If ARB has determined that there are no potential adverse emission impacts for an ADF (the fuel is a Stage 3B ADF) and no mitigation measures and/or sales restrictions are required for that ADF, why then does a "fuel provider" (term not defined) need to submit quarterly reports to the ARB Executive Officer? This reporting seems unnecessary and redundant as ARB implies the production/import volume information will already be captured within LCFS quarterly submittals. Please explain the purpose of this requirement.

ADF 13-43

Appendix 1:
Supplemental Western States Petroleum Association Comments on
ARB's Alternative Diesel Fuel Regulation

Excerpts from the Tier I, II & III Biodiesel MME Reports on
The *Need for Additive Impact Assessment* Prior to Widespread Use

Final Tier III Report[3]
The Executive Summary of the final Tier III MME report for biodiesel states the following related to additives (*emphasis* added).:

From the EXECUTIVE SUMMARY, section Issues of Ongoing Concern:

Additives

- As with air emissions, it should be recognized that, due to the large number of fuel formulations along with the resources and cost required to evaluate each formulation, it is not feasible to assess all combinations of engine types and fuel formulations. This is especially the case with additives, since the number of additive and feedstock combinations could be very large. So it will be important in future assessments to target a smaller set of archetypal and informative combinations of engines and fuel formulations. The *Air Emissions* studies evaluated two additives both for NO_x reduction. Neat biodiesel fuels were also additized with a stability additive to help provide sufficient stability against oxidation throughout the program (Durbin et al, 2011). *Effects of other additives such as biocides and cold flow enhancers may be necessary if these are planned for use. Additional additives for NO_x reduction may also need to be tested prior to widespread use* i.e. urea.

ADF 13-44

- California low-aromatics and -sulfur diesel-fuel formulations require the addition of cetane enhancers to achieve required emissions reductions. These additives are anticipated to be used in biodiesel blends as well. Further reducing the aromatics also can reduce lubricity and most California diesel includes a lubricity additive. Further, when diesel is distributed by pipeline, the pipeline operator may inject corrosion inhibiting and/or drag reducing additives. A typical additive package may contain: a detergent/dispersant, one or more stabilizing additives, a cetane number improver, a low temperature operability additive (flow improver or pour point reducer), and a biocide. Each refiner or marketer is likely to use a different package of additives and a different treat rate. The specific chemical composition of the additives used by various biodiesel manufactures is typically not specified and the environmental impact of these additives is not well described. *The impact from releases of associated additives and production chemicals not yet characterized could be of concern unless state guidelines restrict additives to those already in use and/or already characterized.*

ADF 13-45

[3] http://www.arb.ca.gov/fuels/multimedia/meetings/Biodiesel_FinalReport_May2013_101113.pdf

- However, in the case of B20, it is reasonable to assume that most of the additives used in biodiesel are currently used in CARB ULSD and would continue to be used with no substantive difference in environmental impact due to additives. If this is the case, then new studies on multimedia transport and impact from additives would not be needed *except where impacts in conventional ULSD use are either unknown or unacceptable*.

ADF 13-46

Toxicity

- Assessing the aquatic toxicity of biodiesel is a priority in California for a variety of reasons. First, … *Third, the possibility of additives may also create differences in the toxicity of biodiesel used in California rather than the biodiesel used in previous studies*. ….

ADF 13-47

Transport and Fate

- While the results of the existing biodegradation experiments appear favorable for B100 and biodiesel blends with diesel, further evaluation is needed using the most up to date reference fuel for the state of California, CARB ULSD #2. *In addition, due to various additive components not included in this multimedia assessment that may be necessary to improve fuel combustion properties, additional study of biodegradation is also needed to evaluate the impacts from the additives*. Additives to prevent microbial growth in the fuel during storage and use may lead to significantly reduced biodegradation. Reducing biodegradation may lead to increased transport and mobility in the environment, especially in the subsurface where cleanup is especially difficult. Since biodiesel is a mild solvent, the solvency could potentially remobilize pre-existing chemical compounds in the area affected by a release.

ADF 13-48

Tier II MME Report[4]

The Tier II report stated there are knowledge gaps related to use additives and recommended additional testing:

From EXECUTIVE SUMMARY,

Remaining Tier II Uncertainties

- *Additional testing addressing the potential toxicity of additives including chemical analysis of exposure medium is needed*.
- *Of the three groups of additives only blends with antioxidants, and biocidal additives (biodegradation experiments only) were studied*. Cold flow additives were not studied in any of the performed experiments. The impact of cold flow additives on aquatic toxicity and biodegradation needs to be studied….

ADF 13-49

Tier I Report[5]

[4] http://www.arb.ca.gov/fuels/multimedia/meetings/Biodiesel_FinalTierII_Jan2012_110413.pdf
[5] http://www.arb.ca.gov/fuels/multimedia/meetings/Biodiesel_FinalTierIReport_Sep2009_110413.pdf

The conclusion of the Tier I MME report, it was stated that evaluation of additive impacts needs to be evaluated as part of the Tier II evaluations:

From EXECUTIVE SUMMARY,

Key Information Gaps and the Tier-II Sampling Plan

1. **Additives impacts.** To provide a stable useful, and reliable fuel, additive chemicals will need to be introduced into almost all biodiesel blends. These additives will be required to control oxidation, corrosion, foaming, cold temperature flow properties, biodegradation, water separation, and NOx formation. The specific chemicals and amounts used have not been well defined for the emerging industry in California. A careful evaluation the possible chemicals would be beneficial to California and may lead to a "recommended list" or "acceptable list" that would minimize the uncertainty of future impacts as industry standards are developed.

   The impact of various additives that may be used with *biodiesel blends needs to be considered for releases to the air, water, and soils. Additives may affect fuel quality or storage stability in unintended ways. Because the properties of additives can potentially alter the characteristics of biodiesel, increasing its environmental and health risks, there is a need for additional tests on biodiesel with specific concentrations of additives*. In particular it is necessary to assess the impact of
   - cold flow property controllers on surface water- biodiesel interaction and on subsurface multiphase transport of biodiesel (see number 2 below).
   - biocides and anti-oxidants on biodegradation (see number 3 below).
   - *all priority additives on human and ecosystem toxicity*

ADF 13-50

2. **Subsurface fate and transport properties.** The impacts of leaks and spills of biodiesel fuel product during transport, storage, and distribution have not been addressed. This is an important issue for California. Because the chemical composition of biodiesel differs significantly from that of petroleum diesel, it is expected that infiltration, redistribution, and lens formation on water tables will differ for the two fuels, leading potentially to significant differences in relative impacts to groundwater quality. Properties governing these processes are density, viscosity, and interfacial tensions. *Component (including additive) solubility into the water phase ultimately governs water quality and so inter-phase solubilization of individual components also needs to be identified. To address these issues requires experiments with conventional soil column tests that will be used to establish relative transport behaviors among different fuel compositions* and for site-specific analyses. But the relevance of these results for state-wide assessments should be considered along with the value of full-scale comparative field tests with releases into the groundwater, or into the vadose zone just above the groundwater table.

ADF 13-51

13_OP_ADF_WSPA Responses

69. Comment: **ADF 13-1, ADF 13-2, ADF 13-5 through ADF 13-15, ADF 13-17, ADF 13-18, ADF 13-20, ADF 13-22, ADF 13-29 through ADF 13-31, ADF 13-34 through ADF 13-37, and ADF 13-43 through ADF 13-51. EA**

Agency Response: The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

70. Comment: **ADF 13-3**
The comment requests a longer (three-year) lead time for implementation. The comment also questions the basis of the 2 year lead time being an "established CARB policy" as well as the potential availability and cost of pre-mitigated biodiesel by 2018.

Agency Response:
1.) During the regulatory development process, ARB staff consulted with stakeholders regarding the lead-time to prepare for mitigation. Stakeholder feedback indicated that two years was a reasonable amount of lead-time. Additionally, if ARB were to delay implementation of NOx mitigation, it could have adverse impacts on air quality. Therefore, the Board believes the two-year lead time is reasonable and appropriate.

2.) Lead times are consistent with past ARB practice. However, the existence and length of those lead times are not fixed and are based upon the individual circumstances and difficulties of the particular situation.

3.) Regarding the commenter's concern on the availability and cost of pre-mitigated biodiesel in 2018: In developing the ADF, ARB staff balanced the needs of industry with the potential for NOx emissions impacts from higher blends of biodiesel. Staff therefore concluded, in consultation with stakeholders, that 2 years would be the lead time that would best accomplish that balance. Staff believes that the blend levels below the control levels for in-use specifications are available at current costs and the lead time allows for changing business structures to either allow for more volume at the lower level blends or implementation of mitigated biodiesel options for higher blends. Additionally, the 2 year lead time allows for certification of additional options for in-use requirements under the certification provisions of the ADF regulation.

71. Comment: **ADF 13-4**
The comment recommends additional interim program reviews of the ADF regulation and that these reviews are aligned with deliverables from the LCFS.

Agency Response: Given the timeframe in which the biodiesel in-use requirements will be required, a single program review on the proposed timeframe is sufficient. However, ARB intends to closely monitor the efficacy of the ADF regulation. The LCFS program will be reviewed by January 1, 2019, while the ADF regulation includes provisions for staff to conduct a program review by December 31, 2019. The LCFS and ADF programs are related but distinct programs, so review on the same timeframe is not the most appropriate since review on the same timeframe would be prior to the first year of in-use requirements being complete ARB believes that with the implementation timeline, a review by 2020 is most appropriate. Staff will monitor the program regularly, and consider conducting the ADF program review earlier or more often if significant issues arise that demand changes to the ADF program.

72. Comment: **ADF 13-16**
The comment supports the inclusion of the NOx controls sunset provision for biodiesel and recommends implementing the provision as early as possible. The comment goes on to question how the sunset provision will be implemented and the timing of the sunset.

Agency Response: The 2023 timeframe for the NOx Controls Sunset is an estimate only. It is ARB staff's intention to closely monitor the efficacy of the ADF program and make adjustments to this timeline, if necessary, based on the results of the program review. Please see response **ADF 7-1,** regarding the sun-setting of NOx controls, found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.".

As part of the 15-day proposal, changes were made to the regulatory language. These changes clarify the sunset will be implemented through issuance of an executive order and initiation of a rulemaking process to remove the biodiesel NOx control level requirements from the regulation. The proposal does not include a specific timeline for the issuance of the executive order, as it is not at this time possible to predict exactly when the conditions for the issuance will occur.

73. Comment: **ADF 13-19**
The comment provides costs estimates for formula certification.

Agency Response: ARB staff is aware that certification testing has a range of costs depending on the amount of preliminary testing and

formulation changes necessary for success. These costs were considered in an economic impact analysis conducted for the ADF regulation. It is imperative that the certification procedures be robust in order to preserve the emissions reductions of our fuels programs; therefore, the costs are a necessary consequence of achieving sustainable and responsible use of alternative diesel fuels.

74. Comment: **ADF 13-21**
The comment points out an inconsistency in the use of "virgin soybean oil" under Appendix 1, Par (a)(2)(D) while elsewhere staff references biodiesel by saturation level not feedstock source. The comment goes on to state that the regulation should specify no minimum cetane number (CN) and a maximum CN of less than 56 for low cetane biodiesel certification, and suggests a maximum of 56 CN for high saturation biodiesel certification to ensure low saturation biodiesel is not used.

Agency Response:
1. As part of the 15 day changes, the requirement to use virgin soy oil was changed to require low saturation feedstock for more consistency with the rest of the regulation.

2. The lower limit on CN is required to ensure that test fuels mirror in-use fuels; biodiesel blendstocks are not allowed to have a cetane number less than 47 per ASTM requirements and the ADF proposal.

It is unclear whether the commenter is referring to Executive Orders approving formulas, or to the "formula" of the reference fuel with regard to specifying cetane numbers of biodiesel above or below the cutoff of 56. In either case, ARB staff will administer the program to ensure that fuel testing is robust enough to minimize concerns due to test reproducibility. Additionally, the cetane number cutoff of 56 is a surrogate for determining the emissions effect of soy or soy-like biodiesels from the emissions effect of animal-based or similar biodiesels.

Regardless of cetane number, the regulation's biodiesel certification provisions allow any biodiesel blend up to B20 that is proven to achieve CARB diesel emissions equivalency to be certified upon approval. However, the certification would specify a number of properties including the cetane number of the fuel to be certified, to ensure that the approved fuel blend maintains its emissions equivalency.

3. Certified biodiesel formulas will include a minimum and maximum cetane limit based on the actual cetane or cetane range of the formula tested. This will ensure that the in-use biodiesel performs as well as

the tested biodiesel. However, depending on the formulation, no maximum may be included as higher cetane should yield lower emissions. The minimum cetane limit shall be no lower than 47, as this is the legally allowed minimum. Staff expects certification of individual formulations to be completed without regard to low or high saturation of the formulation and based solely on emissions results. However, if an applicant wishes to self-specify a narrow range or design the formulation in line with low or high saturation cutoffs that will be considered during the test program design.

75. Comment: **ADF 13-23** The comment states that the regulatory language regarding recordkeeping and reporting requirements is not adequately defined. This comment is expanded upon in the next several comments.

Agency Response:
Section 2293.8(b) was revised to clarify that biodiesel blenders are subject to the reporting requirements and what information needs to be reported. In addition, the term 'biodiesel blends' has been added to section 2293.6(a)(1). In short: biodiesel blenders are subject to both reporting and pollutant control level requirements.

76. Comment: **ADF 13-24**
The comment requests clarification on whether the biodiesel reporting requirements apply to blenders.

Agency Response:
Please see response **ADF 13-23**

77. Comment: **ADF 13-25**
The comment requests clarification on whether the pollutant control level requirements apply to blenders.

Agency Response:
Please see response **ADF 13-23**.

78. Comment: **ADF 13-26**
The comment asserts that the ADF regulation is unclear as to what sampling and in-use requirements apply to producers/importers and which requirements apply to blenders.

Agency Response:
This issue was addressed in the response to **ADF 13-23**. Additionally, ARB staff believes it is clear in the 15-day changes that blenders could use product transfer documents to substantiate claims of the method of NOx control if they retain documentation of this transaction.

79. Comment: **ADF 13-27**
The comment requests clarity as to when the statement regarding NOx control is required to be included on invoices.

Agency Response:
As part of the 15-day changes, all transactions must include statements on invoices indicating NOx control for B100 or biodiesel blends. A statement on the Product Transfer Document (PTD) listing saturation and blend levels, when the blend level is below the NOx control level, would make it clear no further NOx control is necessary. The NOx control level is the blend level above which mitigation through in-use specifications is required.

80. Comment: **ADF 13-28**
The comment requests clarity on the purpose of providing results of sampling in Stage 3B (no mitigation required).

Agency Response:
The requirement referenced in the comment has been deleted as part of the 15-day package. Stage 3B fuels are no longer required to provide a specified number of representative samples and may use the Low Carbon Fuel Standard Reporting Tool (LRT) to submit their quarterly reports.

81. Comment: **ADF 13-32**
The comment states that the ADF staff report should give animal biodiesel equal treatment.

Agency Response:
The comment references Appendix G of the Staff Report, which is the supplemental statistical analysis. In that appendix, statistical comparisons of NOx emission are made between B5 soy-based and B5 animal-based biodiesel blends, as well as B10 soy-based and B10 animal-based biodiesel blends. ARB staff feels that these statements provide fair representation of the important differences between animal-based and soy-based biodiesel blends for the summary section. For full details of our conclusions about the statistical significance of all data please refer to the model analyses on page G-7 through G12 in Appendix G of the Staff Report. For more information, please see paragraph on statistical analysis summary in response to comment **ADF 8-1,** in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

82. Comment: **ADF 13-33**
The comment provides information regarding the fact that biodiesel blends above B6 are generally stored above ground and that ARB and State Water Resources Control Board (SWRCB) released a joint statement on the storage of renewable diesel in USTs.

Agency Response:
The commenter is correct regarding both biodiesel and renewable diesel storage in USTs. The Staff Report (p. 25) notes that biodiesel blends above B6 have not undergone independent certification and there is no current activity to obtain certification. , Thus, blends above B6 are generally stored above ground. The commenter is also correct that ARB and SWRCB released a joint statement on the storage of renewable diesel in USTs, renewable diesel may be stored in USTs at any blend level.

83. Comment: **ADF 13-38**
The comment recommends a change to the definition of "biodiesel blend".

Agency Response:
The definition of "*biodiesel blend*" was clarified as part of the 15-day changes. The term was revised to "*biodiesel blended with CARB diesel*."

84. Comment: **ADF 13-39**
The comment points out that the term "diesel substitute" as defined in the ADF proposal is a circular reference.

Agency Response:
ARB staff appreciates the comment and deleted the definition for "*diesel substitute*" in the regulation as part of the 15-day changes. The term diesel substitute was removed from the section 2293.2 and was replaced by "fuels."

85. Comment: **ADF 13-40**
The comment recommends a change to the definition of "hydrocarbon".

Agency Response:
ARB staff updated the definition of hydrocarbon in the regulation as part of the 15-day changes. The term Hydrocarbon now states, "*any homogeneous mixture with elemental composition primarily of carbon and hydrogen that may contain residual impurities."*

86. Comment: **ADF 13-41**
The comment suggests modifications to additive volume limits for CARB diesel exempted from the ADF regulation.

Agency Response:
Please see response **ADF 3-9,** regarding additive volumes..

87. Comment: **ADF 13-42**
The comment states that compliance with the ADF proposal may be difficult due to conflicting ASTM standards adopted by ARB and CDFA Division of Measurement Standards.

Agency Response:
Please see response **ADF 3-11,** regarding the risk of conflicting standards..

Comment letter code: 14-OP-ADF-NLB

Commenter: Jennifer Case

Affiliation: New Leaf Biofuels

The following letter was submitted to the ADF Docket during the 45-day comment period.

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36_OP_LCFS_NLB

14_OP_ADF_NLB

February 17, 2015

Mary D. Nichols, Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95812

RE: **SUPPORT FOR LCFS READOPTION AND ADF REGULATION ADOPTION** at February 19-20, California Air Resources Board Hearing

Dear Chair Nichols:

I am writing to express our support of both the re-adoption of the Low Carbon Fuel Standard ("LCFS") and the adoption of the Alternative Diesel Fuel ("ADF") regulation. We want to thank the leadership and staff at the Air Resources Board (ARB) for all of the hard work on these very important issues to Californians, and applaud you on implementing a program that has served as a blueprint for other carbon reduction plans all over the country.

LCFS 36-1

My friends and family started New Leaf Biofuel in San Diego in 2006. Our mission was, and is, to convert used cooking oil into biodiesel, which we then sell back to the community in order to create local jobs at our plant and to reduce greenhouse gas emissions caused by the burning of fossil fuels. We chose to locate our production facility in Barrio Logan because we wanted to contribute to an economically disadvantaged community. Our mission has always focused on serving as a model for economic, environmental, and social sustainability.

Over the years, New Leaf, and the biodiesel industry in general, has faced enormous challenges. These include lack of infrastructure, unstable federal policy, and opposition from fossil fuel interests—just to name a few. The Low Carbon Fuel Standard is a critical policy that demonstrates California's commitment to the environment, and provides stability that will spur investment and innovation to further our carbon reduction goals. We, therefore, fully support the re-adoption of the Low Carbon Fuel Standard.

LCFS 36-2

I recognize that the process to craft the ADF regulation has been challenging, and I appreciate your efforts to keep the interests of all stakeholders in mind. Importantly for New Leaf and other community-sized businesses that serve smaller diesel markets, we are particularly supportive of the implementation timeline that is designed to allow our industry to certify an

ADF 14-1

additive "solution," improve infrastructure, or otherwise adjust business plans to comply with the ADF regulation. ADF 14-1 cont.

We also look forward to continuing to work with the ARB on the evaluation of options that would allow limited, district-specific exemptions for some fleets to continue use of biodiesel blends up to and including 20 percent (B20). We are optimistic that by continuing to work together, we can strike a balance that will address the air quality and public health concerns particular to each part of the state, while achieving the objectives of the Low Carbon Fuel Standard. ADF 14-2 LCFS 36-2

Again, thank you for your work on this important issue and for your interest in understanding New Leaf's perspective.

Sincerely,

New Leaf Biofuel, LLC

a California limited liability company

Jennifer Case, President

14_OP_ADF_NLB Responses

88. Comment: **ADF 14-1**
The comment supports the adoption of the ADF regulation.

Agency Response:
ARB staff appreciates the comment in support of the ADF proposal.

89. Comment: **ADF 14-2**
The commenter would like to work with ARB to develop limited, district-specific exemptions.

Agency Response:
Section 2293.6(a)(5) of the ADF contains provisions for exemption from in-use requirements. A person may request an in-use requirement exemption by submitting an application to the Executive Officer. ARB staff has worked with stakeholders to develop a provision in the exemption section included as part of 15-day changes to include a limited exemption for producers and fleets outside of the San Joaquin and South Coast Air Basins that meet specified conditions.

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Comment letter code: 15-OP-ADF-Oberon

Commenter: Rebecca Boudreaux

Affiliation: Oberon Fuels

The following letter was submitted to the ADF Docket during the 45-day comment period.

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15_OP_ADF
_Oberon

2445 Fifth Avenue
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San Diego, CA 92101
(619)255-9361

February 17, 2015

California Environmental Protection Agency
Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: **Proposed Regulation on the Commercialization of Motor Vehicle Alternative Diesel Fuels**

To Whom It May Concern:

Oberon Fuels supports the proposed CARB Alternative Diesel Fuel Regulation regarding the Commercialization of New Alternative Diesel Fuels. As an innovative, San Diego-based company, having a clear pathway by which emerging fuels such as dimethyl ether (DME) can be certified by the state of California is imperative. These proposed regulations provide that clarity.

As background, Oberon Fuels is launching DME in North America as a cleaner alternative to diesel for the truck, agricultural, and construction markets. Using various, domestic feedstocks such as food waste, landfill gas, and flare gas, Oberon has developed a small-scale process that cost-effectively converts two greenhouse gases, methane and carbon dioxide, to DME. DME is a clean-burning, non-toxic, potentially renewable fuel that offers diesel-like performance with propane-like handling properties. With a high cetane number (55-60) and quiet combustion, DME is an excellent diesel alternative that will meet strict emissions standards and assist in lowering greenhouse gases. Oberon Fuels' first facility in Brawley, California came online in the Summer of 2013 and is producing fuel-grade DME that is being used in US-based demonstrations of heavy-duty, DME-powered Volvo trucks.

On the regulatory front, Oberon is working with a variety of state and federal agencies to ensure that the proper regulations are in place to support the commercialization of DME as a transportation fuel:

- **CARB.** Oberon is currently working with CARB to navigate the Multimedia Assessment process, which has recently moved to Tier 2. DME Tier 1 Report was posted to CARB's website on February 13, 2015.
- **ASTM International** passed a new standard specification ASTM D7901-14b for "Dimethyl Ether for Fuel Purposes" initially in February 2014 with two, updated versions passed later in 2014.
- **California Department of Food and Agriculture (CDFA).** Because of the establishment of this ASTM consensus standard, DME is now approved for use as vehicle fuel in the state of California. CDFA filed new regulations to the California Code of Regulations with the Secretary of State, legalizing dimethyl ether for use in vehicles, after the passing of the ASTM Specification for DME as a transportation fuel.

- **EPA.** Biogas converted to DME by the Oberon process is now eligible for both D-3 and D-5 RINs credits under the EPA's Renewable Fuel Standard. EPA determined that Oberon's biogas-based DME resulted in 68% reduction in greenhouse gases.

Greenhouse Gas (GHG) Reduction; AB32 goals. DME will assist in GHG reduction, as it will contribute to the displacement of the 2.6 billion gallons of diesel currently used in California. Pure DME contains no sulfur compounds, which makes it a clean burning fuel that generates no SOx or particulate matter in the exhaust gas. Additionally, because DME can be made from biogas, the production process sequesters both carbon dioxide and methane, which further reduces GHG emissions in California. Volvo has tested DME engines in heavy-duty applications since 1999, first with a DME-powered bus. Current Volvo demonstrations of DME in Europe show a 95% reduction in CO_2 emissions for commercial operations when using black liquor as a feedstock. These results demonstrate that DME production will continue to assist with California's emission requirements codified in AB32.

Proposed Regulation Streamlines Fuel Certification Process. The proposed regulation will allow companies to more effectively navigate the fuel certification process. This regulation proposes to outline the specific testing and emissions evaluations that CARB requires when certifying a fuel. By compiling the information, companies will only have to review one source of requirements to determine what they need to test for during the certification. Providing the specific criteria ahead of time will also streamline the process and allow for companies to be able to prepare themselves for the required multimedia evaluation. While we understand that many of the provisions of this regulation are already legally required, we believe that placing the framework in one regulation will increase understanding and allow innovative companies to more quickly bring safe and viable alternative fuels to market.

Local Benefits. Streamlining the commercialization of DME will immediately assist with reduced emissions, better air quality, and more green jobs in California.

Oberon strongly believes that the proposed CARB Alternative Diesel Fuel Regulation will allow us to more quickly bring a viable and clean fuel to market, while providing guidance as well to additional fuels that may arise in the future.

Please feel free to contact us should you have any questions or if we can offer additional support.

All the Best,

Rebecca Boudreaux

Rebecca Boudreaux, Ph.D.
President, Oberon Fuels

15_OP_ADF_Oberon Responses

90. Comment: **ADF 15-1**
The comment supports the adoption of the ADF regulation.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF regulation.

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Comment letter code: 16-OP-ADF-POET

Commenter: Joshua Willter

Affiliation: POET

The following letter was submitted to the ADF Docket during the 45-day comment period.

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16_OP_ADF _POET

POET
HUMAN + NATURE
O / 605 965 2200 4615 N. LEWIS AVE. SIOUX FALLS, SD 57104 POET.COM

February 17, 2015

By Electronic Mail

Clerk of the Board
California Air Resources Board
1001 I Street, 23rd Floor
Sacramento, CA 95812

Re: Proposed Amendments to the California Low-Carbon Fuel Standards Regulation and the Proposed Regulation of the Commercialization of Alternative Diesel Fuels

Dear Madam:

POET LLC, a member of Growth Energy, concurs in the comments being filed today by Growth Energy, including the environmental analysis under the California Environmental Quality Act offered by Growth Energy, as well as the alternative to the above-captioned proposed amendments and regulations that have been proposed by Growth Energy. Please file this letter in the two separate dockets for the the proposed amendments to the California Low-Carbon Fuel Standards ("LCFS") regulation and the proposed regulation of the commercialization of alternative diesel fuels

ADF 16-1

POET LLC expects to file additional comments prior to the close of the record in the LCFS proceeding.

Thank you for your consideration and assistance.

Sincerely,

Shailesh Sahay
Regulatory Counsel

Revised POET CEQA concurrence 17 feb

16_OP_ADF_POET Responses

91. Comment: **ADF 16-1**

Agency Response:
The respons to this comment is in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

Comment letter code: 17-OP-ADF-GE

Commenter: Joshua Willter

Affiliation: Growth Energy

The following letter was submitted to the ADF Docket during the 45-day comment period.

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growth energy
America's Ethanol Producers

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PHONE 202.545.4000 FAX 202.545.4001

46_OP_LCFS_GE

17_OP_ADF_GE

February 17, 2015

By Electronic Mail

Clerk of the Board
California Air Resources Board
1001 I Street, 23rd Floor
Sacramento, CA 95812

Re: Proposed Amendments to the California Low-Carbon Fuel Standards Regulation and the Proposed Regulation of the Commercialization of Alternative Diesel Fuels

Dear Madam:

Growth Energy, an association of the nation's leading ethanol manufacturers and other companies who serve the nation's need for alternative fuels, is submitting to you the enclosed materials in response to the Executive Officer's notices of proposed amendments to California Low-Carbon Fuel Standards regulation and of the proposal to adopt a regulation for the commercialization of alternative diesel fuels. These materials also include environmental comments being submitted to the Air Resources Board and the Executive Officer pursuant to the California Environmental Quality Act and the Board's implementing regulations.

The Executive Officer has created separate rulemaking files and Board hearing agenda items for these two proposals. In view of the substantial overlap between these two proposals, including in the CARB staff's environmental assessment documentation, I ask that all of these materials, including the appendices and exhibits, be included in each rulemaking file and be considered by the Board in connection with each agenda item.

Growth Energy may file additional materials in one or both rulemaking files for consideration in connection with one or both agenda items at a later time, as permitted by the California Government Code.

If there are logistical questions concerning these submittals, please contact Mr. James M. Lyons of Sierra Research, Inc., at 916-444-6666.

Thank you for your consideration and assistance.

Sincerely,

David Bearden

David Bearden
General Counsel and Secretary

STATE OF CALIFORNIA

AIR RESOURCES BOARD

PROPOSED AMENDMENTS TO THE CALIFORNIA LOW CARBON FUELS STANDARD REGULATION AND THE PROPOSED REGULATION ON THE COMMERCIALIZATION OF ALTERNATIVE DIESEL FUELS

GROWTH ENERGY'S RESPONSE
TO THE NOTICES OF PUBLIC HEARINGS DATED DECEMBER 16, 2014
2015 CAL. REG. NOTICE REG. 13, 45 (JANUARY 2, 2015)

FEBRUARY 17, 2015

For further information contact:
Mr. Chris Bliley
Director of Regulatory Affairs
Growth Energy
CBliley@growthenergy.org
202-545-4000

Executive Summary

On January 2, 2015, the Executive Officer of the California Air Resources Board commenced the formal process of proposing amendments to the California low-carbon fuel standard ("LCFS") regulation and the adoption of a new regulation to govern commercialization of alternative diesel fuels used to comply with the LCFS regulation (the "ADF regulation"). Growth Energy shares CARB's goal of promoting alternative fuels that have lower greenhouse gas impacts than fossil fuels. In fact, promotion of this goal is central to Growth Energy's purpose. Unfortunately, Growth Energy believes that CARB's execution of the LCFS program as proposed would run counter to this goal. The proposal if finalized would promote the wrong fuels based on flawed, incorrect science, and as a result impose significant costs without accompanying greenhouse gas reductions. Thus, Growth Energy opposes adoption of the proposed amendments to the LCFS regulation and the currently proposed ADF regulation. Each regulation is unnecessary to achieve the environmental benefits sought by the California Legislature in the Global Warming Solutions Act of 2006, which is the statute on which the Executive Officer is basing his proposal.

The LCFS regulation is no longer needed to achieve the greenhouse gas reductions sought in the 2009 LCFS regulation, and Growth Energy has proposed a better alternative to the LCFS through the expansion of the existing cap-and-trade program. Since the Board first adopted the LCFS regulation in 2009, much has changed in efforts by the state and federal government to reduce greenhouse gas ("GHG") emissions from motor vehicles. Growth Energy presented a proposed alternative to the LCFS regulation to CARB staff in June 2014. Following review of Growth Energy's proposal, the CARB staff agreed with Growth Energy that Growth Energy's proposal would likely achieve the same level of GHG emissions reductions as the 2009 LCFS regulation through 2020. Growth Energy's proposal had none of the unintended negative environmental consequences of the 2009 LCFS regulation, which have been the subject of litigation, and would have eliminated the need for California businesses and consumers to pay for the LCFS program ─ costs which the CARB staff now says may range up to about 12 cents per gallon by 2020.

The new justification for the LCFS regulation ignores the federal renewable fuels program. The CARB staff rejected Growth Energy's proposed alternative to the LCFS regulation in the fall of 2014 because it claimed that by enforcing LCFS requirements now, CARB could prepare the California fuels market for further GHG reductions after 2020. The CARB staff theorized that only an LCFS program can adequately assure the diversification of the sources and methods of producing renewable fuels with low carbon emissions needed to achieve GHG reductions after 2020. When it rejected Growth Energy's proposal last fall, the CARB staff did not properly account for the beneficial effects of the federal renewable fuels standards ("RFS") program in stimulating fuels diversification and in the commercialization of cellulosic renewable fuels. The CARB staff still has not done so.

LCFS 46-1

By disrupting the national market for renewable fuels, the LCFS regulation may increase global greenhouse gas emissions. Under the new LCFS regulation, corn ethanol produced at Midwest biorefineries will likely be displaced in large part by sugarcane ethanol from Brazil. Midwest corn ethanol biorefineries will be forced to choose between curtailing or shutting down production, or finding other markets for the ethanol that can no longer be sold in California. Because external economic factors constrain the output of the Brazilian sugarcane ethanol industry, and may continue to do so, the practical effect of the new LCFS regulation may be the shipment of Brazilian ethanol to California and Midwest ethanol to Brazil. The ethanol would travel on oceangoing tankers powered with fossil fuels. Intercontinental shipments of ethanol in response to California's regulation would have the unintended effect of increasing global GHG emissions.

LCFS 46-2

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Appendices A – J

Comments of Growth Energy on Proposed Amendments to the California Low Carbon Fuels Standard Regulation and the Proposed Regulation on the Commercialization of Alternative Diesel Fuels

Growth Energy respectfully submits these comments on the proposed amendments to the low-carbon fuels standard ("LCFS") regulation and the proposed regulation on the commercialization of alternative diesel fuels. Growth Energy is an association of the leading ethanol producers in the United States and other companies that serve America's need for renewable fuels. As such, Growth Energy shares in a core goal of the LCFS program – the promotion of alternative fuels that lower transportation-sector greenhouse gas emissions, among other benefits. Growth Energy's comments for the California Air Resources Board ("CARB" or "the Board") are contained in this summary document and a number of appendices and exhibits. Growth Energy is combining in these comments its response to the notices of proposed rulemaking published for the LCFS regulation and the alternative diesel fuel ("ADF") regulation, which are both scheduled for a public hearing later this week, as well as its response to the consolidated draft Environmental Assessment ("the draft EA") for the LCFS and ADF proposals.[1]

Part I of these comments outlines some of the key statutory provisions that govern the LCFS and ADF rulemakings and identifies the CARB staff's serious shortcomings in complying with the same. Part II summarizes the analysis contained in the appendices to Growth Energy's comments on the lifecycle emissions analysis used in the LCFS regulatory proposal and the impacts of the LCFS proposal on consumers, businesses, and federal law and policy, as well as related issues. Part III and its accompanying appendices address the draft EA and other issues

LCFS 46-3

[1] The public hearing notices dated December 16, 2014, and the draft EA were posted for public review and comment by the Executive Officer on January 30, 2014.

involving the environmental impacts of the two proposals and outline the Board's duties based on the record under the California Environmental Quality Act ("CEQA").[2] Part IV summarizes an alternative to the LCFS regulation that Growth Energy presented to the CARB staff, evaluates the CARB staff's response to Growth Energy's proposal, and describes the Board's legal obligations under the Government Code in light of the current record. Part IV also presents recommendations to facilitate the transparency and external review of the two current regulatory proposals.

LCFS 46-3 cont.

I. STATUTORY FRAMEWORK AND BACKGROUND

The Board's consideration of the LCFS amendments and the proposed ADF regulation is governed by the California Government Code, the California Health & Safety Code, and CEQA, as well as the California and federal Constitutions. Pertinent requirements of CEQA and CARB's certified regulatory program to implement CEQA that apply to the draft EA are examined in detail in Part III and Appendix J of these comments. Because they are relevant to every aspect of these two rulemakings, it is important at the outset to identify three key provisions of the Global Warming Solutions Act of 2006 ("AB 32") and the Government Code that apply here.

LCFS 46-4

Any regulation adopted by the Board must be consistent with and reasonably necessary to accomplish the purposes of AB 32. *See* Cal. Gov't Code § 11342.2. Three provisions of AB 32 are important to the Board's review of the CARB staff's proposal in order to determine whether the proposal is consistent with AB 32. First, regulations to implement AB 32 must not "interfere with … efforts to achieve and maintain federal and state ambient air quality standards" to the extent feasible, in addition to being adopted in a manner that complies with CEQA. Cal. Health & Safety Code § 38562(b)(4). Second, the emissions reductions that CARB attributes to an AB 32

LCFS 46-5

[2] Growth Energy may file additional materials not directly pertinent to the draft EA but relevant to other issues presented in the rulemaking prior to the start of the public hearings this week.

regulation must be "real, permanent, quantifiable, verifiable and enforceable." *Id.* § 38562(d)(1).[3] Third, AB 32 directs that the Board "shall" rely upon "the best available economic and scientific information" when adopting regulations to implement AB 32. *See* Cal. Health & Safety Code § 38562(e). For the reasons explained in these comments and the appendices, the proposed amendments to the LCFS regulation do not comply with those three central provisions of AB 32, and therefore the Board should not adopt them.

LCFS 46-5 cont.

In addition, the Executive Officer cannot demonstrate that the LCFS amendments are "reasonably necessary" to meet the purposes of AB 32, as the Government Code requires. As the CARB staff admitted during the Department of Finance's review of the proposed amendments last fall, the LCFS regulation is likely not necessary in order to reduce greenhouse gas ("GHG") emissions prior to 2020; another, less burdensome alternative identified by Growth Energy would achieve those reductions and would not have the counterproductive impact on the California environment that the LCFS regulation will create.[4] In earlier comments to the CARB staff during development of the new LCFS regulation, Growth Energy explained that the limited purposes of the LCFS regulation were already accomplished by other programs. Having been presented with Growth Energy's alternative to the LCFS regulation, CARB cannot properly claim that no alternative to the LCFS program would be "as effective and less burdensome to affected private persons and equally effective in implementing the statutory purpose or other provision of law" — an averment required by section 11346.5(a)(13) of the Government Code, and which is important in protecting the public from unnecessary regulation. Remarkably, the Executive Officer's

LCFS 46-6

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[3] Notably, the requirements in subsection (d) of section 38562 are not qualified by the limitation in subsection (b), *i.e.*, "to the extent feasible."

[4] Regarding those impacts, *see* Part III and Appendix I (Declaration of James M. Lyons).

December 2014 notice proposing the LCFS amendments does not even refer to the alternative measure proposed by Growth Energy, which was presented to the CARB staff in June 2014.[5]

LCFS 46-6 cont.

The Legislature heightened the importance of evaluating alternatives to proposed regulations in 2011, when it amended the Government Code in order to require agencies to present their regulatory proposals to the Department of Finance for early review of costs, benefits, and alternative methods of accomplishing an agency's regulatory objectives. The LCFS and ADF rulemakings are among the first to be governed by the 2011 amendments, contained in SB 617. For the LCFS regulation, the CARB staff disabled meaningful stakeholder input into the SB 617 review by severely limiting the time permitted for regulated parties to participate, and by failing to fully disclose all the estimated benefits or costs of the proposed regulation (an omission that continues to this day). The shortfall in the SB 617 process for the ADF rulemaking was even greater: the version of the ADF regulation that the CARB staff submitted to the Department of Finance differed in material ways from the version of the ADF regulation that the CARB staff had under active consideration at the time of its SB 617 submission to Finance. Thus, the agency that the Legislature intended to have an active role in the development of major regulations in California ─ the Department of Finance ─ has never formally reviewed the key features of the ADF regulation. Unless the Board itself directs the CARB staff to comply with SB 617, it will be left to another agency (the Office of Administrative Law) to correct this egregious violation of SB 617.

LCFS 46-7

ADF 17-1

In addition to mandating early review of regulatory proposals by the Department of Finance, the Legislature requires transparency in the rulemaking process, so that the public can

LCFS 46-8 cont.

[5] *See* Appendix F and related exhibits.

participate effectively in that process. *See, e.g.*, Cal. Gov't Code § 11347.3; Cal. Health & Safety Code § 39601.5. The public rulemaking file required by section 11347.3 of the Government Code is critical to both transparency and public participation. Section 11347.3 requires, in essence, that the public have the same access to all the data and analysis used by an agency in developing regulations, as well as all external input provided to an agency in connection with the adoption or amendment of a regulation.

As indicated in Part IV of these comments, there are substantial questions concerning the Executive Officer's compliance with section 11347.3, in light of the sparseness of the CARB staff's documentation for key parts of its LCFS and ADF proposals. The CARB staff also waited until nearly the last possible moment to open the rulemaking file, which had the effect if not the purpose of limiting public analysis of the empirical and analytical basis for its proposals. While section 11347.3 of the Government Code applies to all California administrative agencies subject to the California Administrative Procedure Act (the "APA"), section 39601.5 of the Health & Safety Code was added to the Board's enabling statute in 2009 by AB 1085, when the Legislature learned of significant shortcomings in transparency in earlier rulemakings. Section 39601.5 compels CARB to provide "all information" on key aspects of its regulatory analysis "before the public comment period for any regulation" commences under the Government Code. It is unclear how the Executive Officer tried to comply with section 39601.5 in these rulemakings. What is clear, however, is that critical information about the assumptions and data on which the LCFS and ADF proposals are based has never been provided to the public.

LCFS 46-8 cont.

II. REGULATORY ANALYSIS

The use of lifecycle analysis ("LCA") in assessing GHG emissions is at the heart of the LCFS regulation. The Legislature has directed that programs like the LCFS regulation rely on the "best available economic and scientific information"; notably, this mandate applies to the carbon

LCFS 46-9

intensity ("CI") values that CARB assigns to the various renewable fuels in the LCFS regulation, as well as to all other parts of the rulemaking.[6] The use of the most scientifically defensive CI values is critical to the rulemaking effort. The CI values provide what the 2009 Initial Statement of Reasons (ISOR") for the LCFS regulation called "signals" to the downstream fuel industry that will direct them to achieve reductions in the CI of the fuels they sell in the most cost-effective manner. Insofar as the intent of the LCFS regulation is to reduce GHG emissions, the regulation must establish "the maximum technologically feasible and cost-effective" method of doing so. Cal. Health & Safety Code § 38561(a). If the CI values send the wrong "signal" to the downstream regulated parties, then the LCFS regulation will result in the use of pathways that may increase GHG emissions above the levels that would result if the best possible CI values had been assigned to various renewable-fuel pathways in the regulation. As one witness affiliated with the University of California stated at the April 2009 Board hearing on the LCFS regulation:

> [I]f we make a mistake in one direction in estimating these numbers, we'll use too much of a biofuel that's actually higher carbon [than] we thought and will therefore increase global warming. And if we use numbers that are too low, then we'll use too little of a biofuel that's lower carbon than we thought and will therefore increase global warming.

Transcript of Public Meeting of the Air Resources Board, April 23, 2009, at 73-74. As explained in Appendices A, B, and C to these comments, and as summarized below, the "signals" that CARB's new California GREET 2.0 and indirect land-use change models provide for corn-starch, corn-stover and sugarcane ethanol do not reflect the best available scientific and economic

LCFS 46-9 cont.

[6] *See* Cal. Health & Safety Code § 38562(e). The Legislature has not directed CARB to use carbon intensity as a regulatory mechanism; that is a choice the Board made in the 2009 LCFS regulation and that the CARB staff proposes to continue.

information, and therefore do not provide the accurate "signals" to the downstream industry that are needed to maximize GHG reductions while minimizing costs. To adapt the 2009 formulation of the issue, quoted above: the "numbers" for sugarcane ethanol are "too low" and as a result, "too little" corn-starch and corn-stover ethanol would be used in California gasoline, if the Board adopts the staff's proposal. (*See* Section A.1 & 2 below.)

LCFS 46-9 cont.

In addition, if the currently-proposed regulation were to be adopted, the displacement of corn ethanol that would result will severely interfere – once again as in earlier years of the LCFS program – with the federal renewable fuels standard ("RFS") program, in violation of federal law. No purpose is served by the State's conflict with federal law, because as also explained below, the regulation of CI at Midwest corn-starch ethanol biorefineries serves no beneficial purpose; contrary to the staff's claims in the current rulemaking, those biorefineries cannot and will not attempt to change their production methods solely to achieve lower CI scores in response to the LCFS regulation. In that particular respect the LCFS program violates an important tenet of AB 32, because it does not achieve "real" reductions in GHG emissions,[7] despite claims to the contrary. (*See* Section B below.)

LCFS 46-10

A. The CARB Staff's Lifecycle Emissions Analysis and its Consequences

1. Indirect Land-Use Change

From its inception, one of the most controversial aspects of the LCFS program has been its attempt to incorporate the theory of indirect land-use change ("ILUC") into regulation.[8] The

LCFS 46-11

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[7] *See* Cal. Health & Safety Code § 38562(d)(1).

[8] It remains Growth Energy's position that the ILUC theory and the methods used to quantify the impacts of biofuel usage on land change, as well as the emissions model used by CARB to estimate emissions from land change, are too unreliable for use in regulation.

concept of ILUC stands at the intersection of environmental science and economics; having made the decision to try to use the ILUC theory in the LCFS program, CARB can be expected to comply with AB 32, and to use the "best available" scientific and economic information. As explained in Appendix A of these comments, the CARB staff has continued to ignore efforts by stakeholders to improve the quality of CARB's ILUC and indirect-emissions models, as well as recommendations of the Expert Working Group ("EWG") that CARB established when it first adopted the LCFS regulation. CARB must now finally address or adopt each of the recommendations presented in Appendix A, and in Growth Energy's other appendices to these comments, or explain fully why it is not doing so. *See* Cal. Gov't Code § 11346.9(a)(3). Insufficient time to address the recommendations in Appendix A is not sufficient justification for rejecting any of them; Growth Energy and other parties offered those recommendations before the staff published its current proposal and, in some instances, *at least four years ago*. (*See* Appendix A at A-2 and Table 1.) In the text below, Growth Energy summarizes some of the key deficiencies in the new ILUC analysis offered by the CARB staff for the Board's review.[9]

LCFS 46-11 cont.

These are among the recommendations in Appendix A:

- *Price-yield response factor*s. The CARB staff's ILUC analysis for corn-starch ethanol uses a range of price-yield values, despite recommendations from the

LCFS 46-12

[9] Each Appendix to the main text of Growth Energy's comments are a fully incorporated part of Growth Energy's comments. The Board must respond fully to each objection and recommendation in the appendices to the main text of these comments, regardless of their placement, or, at a minimum, explain why it believes each of these objectives or recommendations to be "irrelevant." *See* Cal. Gov't Code § 11346.9(a)(3). To ensure compliance with that requirement of the Government Code, California courts will conduct *de novo* review using independent judgment. *Cf. POET LLC v. California Air Resources Bd*. (2013) 218 Cal. App. 4th 681, 747-48. Particularly when the facts concerning CARB's actions in the regulatory process cannot be a subject of genuine dispute, "the independent standard of appellate review" applies. *Id.* at 748.

LCFS 46-13

authors of the model that CARB uses, as well as the EWG, that the most scientifically defensible value is 0.25. In the ISOR for the LCFS regulation, the Executive Officer relies on a non-peer-reviewed data review by a researcher at the University of California-Davis retained by CARB to support a lower price-yield value. In addition to lacking full documentation, the Davis reviewer appears to have made unexplained, selective use of other research, by Dr. J.F.R. Perez at Purdue University. The CARB staff has not supplied critical missing information from the Davis review requested by Growth Energy, and at this juncture, Growth Energy has no choice but to question whether the Davis review used reliable methods. Certainly, the Executive Officer cannot claim that the staff's work on price-yield responses has been transparent, nor that it is based on the "best available" information: information that is not made available to the public during a rulemaking governed by the California APA is akin to having no information at all.[10]

LCFS 46-12 cont.

- *Multiple cropping*. Last year, researchers at Iowa State University ("ISU") published a study that compared the results of ILUC modeling using GTAP (the modeling system used by the CARB staff) with real data. The study showed that over the last 10 to 15 years, there has been no net land conversion from forest and pasture to cropland in many regions of the world. (*See* Appendix A, note 5.) The ISU study confirms that increases in crop prices (a theoretical result of biofuels mandates like the LCFS regulation) will result in multiple cropping. The CARB

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[10] If the Board directs the Executive Officer to provide the missing information concerning the Davis review, it must follow the procedures in section 11347.1.

staff has ignored that study in its rulemaking proposal and supporting materials. The CARB staff has also ignored a November 2014 submission by Growth Energy that demonstrated how the ISU work could be adapted to correct the results of GTAP. Since at least 2009, the CARB staff has known about the inability of GTAP to account for multiple cropping; Growth Energy supplied a method to correct that deficiency. If the CARB staff did not agree with Growth Energy's approach, it should have developed and applied its own. Choosing instead to completely ignore the ISU study violates the Legislature's requirement to use the "best available" information. If the staff's position is that it had too little time or resources to include the ISU work in its new proposal, then the solution is simple: the Board should give the staff the resources it needs and direct the staff to return to the Board, before the Board attempts to act on the current LCFS proposal.

LCFS 46-14 cont.

- *CRP Land.* A lack of time or resources to update GTAP is also not a valid reason for the CARB staff's steadfast refusal to include the effects of the Conservation Reserve Program ("CRP") land in mitigating the land-use-related emissions impacts that the CARB staff attributes to corn-starch ethanol. In March 2014, Growth Energy supplied CARB with direct evidence from U.S. Department of Agriculture statistics showing that CRP land conversion has occurred in the last five years. The GTAP system already includes computer code to "access" CRP land, as Appendix A points out. In other words, CARB has a model that can account for CRP land conversion and was provided with CRP conversion data almost a full year ago. But apparently nothing has been done with this issue in the

LCFS 46-15

CARB staff's new proposal, and the reasons why the staff has not done so are not clear in the materials provided to the public.

LCFS 46-15 cont.

- *The AEZ-EF and CCLUB models*. The CARB staff's current LCFS proposal uses a model called the "Agro-ecological Zone Emission Factor" model (or "AEZ-EF") to estimate GHG release caused by various theoretical land transitions. In 2013, the researchers at the Argonne National Laboratory ("Argonne") released an updated version of an alternative model that serves the same purpose as AEZ-EF called the "Carbon Calculator for Land Use Change from Biofuels Production" model (or "CCLUB"). The 2013 CCLUB model includes more detailed emissions-related information for the United States than the AEZ-EF model. The land-use change emissions estimated with AEZ-EF and CCLUB differ substantially. (*See* Appendix A, Table 2.) Although the CARB staff has claimed in at least one stakeholder discussion to have evaluated CCLUB, there is no indication of its having done so in the AEZ-EF documentation, the ISOR for the current regulatory proposal, or the staff's accompanying materials. In order to determine whether the CARB staff is using the "best available" science, the Board and stakeholders are entitled to know why the CARB staff has chosen to use AEZ-EF rather than CCLUB.

LCFS 46-16

The potential magnitude of the errors in the CARB staff's ILUC analysis, and thus in the "signals" concerning the CI of corn-starch ethanol created by the proposed new LCFS regulation, are large. These false signals threaten to undermine the very purpose of the LCFS by promoting fuels that will not necessarily reduce greenhouse gas emissions and may even increase emissions. Having now been provided with Appendix A to these comments ─ which largely restates various

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objections to the staff's current approach and corrective recommendations that Growth Energy has previously presented[11] — the Board can and must address these issues. If CARB relies on information not currently in the rulemaking to explain its reasons for not accepting Growth Energy's objections and recommendations, it must place that information in the rulemaking file and allow sufficient time for public review and comment. (*See* note 9 above.) If no such information is forthcoming, then the alternate explanation is that the Board is relying on conjecture and unsupported assumptions, rather than the "best available" information. Alternatively, if the Board is convinced that more time and resources are needed to address the issues presented in Appendix A, it should either suspend the LCFS program or maintain the regulatory status quo until the staff is prepared to bring a new proposal back to the Board.

LCFS 46-17 cont.

2. California GREET 2.0

In Appendices B and C, Growth Energy comments on the portions of California GREET 2.0 ("CA GREET 2.0") used in the CARB staff's new LCFS proposal to generate direct-CI values pertaining to corn and sugarcane ethanol. There are several issues identified in Appendices B and C that CARB must address:[12]

- *Impacts of land-use change on methane emissions*. Enteric fermentation, which occurs in the digestive system of ruminant animals, produces methane, which AB 32 treats as a greenhouse gas. The models used in LCA analysis that attribute the creation of additional

LCFS 46-18

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[11] Some of the relevant earlier submissions by Growth Energy are included in Appendix A. Other stakeholders may have advanced similar objections and recommendations, or commented on the same issues. It is impossible to know if that has occurred, however, because the CARB staff has apparently interpreted the Government Code not to require it to have placed all such submissions in the rulemaking file for this proceeding. *See* Part V below.

LCFS 46-19

[12] *See* note 8 above.

cropland to biofuel mandates also posit that the increase in cropland will reduce the land area available for grazing animals (unless additional land is cleared for grazing); one result of that reduction in grazing area, or a need to clear more land, will be an increase in livestock prices, a reduction in demand for meat, and smaller herds. As Appendix B notes, EPA's LCA analysis has accounted for this indirect reduction in methane emissions in the RFS program's LCA analysis. The CARB staff, however, has not done so in CA GREET 2.0 or in other parts of its new LCFS proposal, even those this omission has been repeatedly called to the staff's attention. Unless the CARB staff has a sound theoretical or empirical basis for disagreeing with EPA's judgment that a sound LCA-based program should account for the reductions in total methane emissions that will result from any land-use changes predicted from biofuels policies, the CA GREET 2.0 model should be modified to come into line with EPA's approach.

LCFS 46-18 cont.

- *Credit for reductions in methane emissions resulting from the use of DGS*. Livestock fed with a coproduct of corn-starch ethanol production, called distillers grain solubles ("DGS"), experience lower rates of enteric fermentation and therefore release less methane. Accordingly, Argonne's current GREET model (called "GREET 1-2013") gives "credit" to corn-starch ethanol production that includes the production of DGS. By contrast, CA GREET 2.0 does not, ostensibly because the CARB staff does not consider the feeding of animals to fall within the LCA system boundary for corn-starch ethanol. In addition to running counter to the judgment of Argonne's experts, who included a DGS credit for reductions in methane emissions, the CARB staff's approach is arbitrary. The entire ILUC theory is itself based on economic assumptions that are untestable; if the theory itself is

LCFS 46-20

sound enough for inclusion in a regulatory program, then there is no reason to exclude the credits for DGS production recognized by Argonne.

LCFS 46-20 cont.

- *Backhaul emissions.* In a regulatory program involving multiple fuel pathways, like the LCFS regulation, the LCA analysis must treat pathways that use different feedstocks in a consistent manner, unless there is sufficient basis to treat them differently. As Appendix C points out, of all the liquid fuels included in CA GREET 2.0, only one (ethanol made from sugarcane) is not charged with so-called "backhaul emissions," which are intended among other purposes to account the GHG emissions attributed to a vessel that has transported liquid fuel to a given destination after it departs for another port. In the case of sugarcane ethanol, which reaches the United States via ocean tankers, the omission of backhaul emissions has a significant impact on its assigned CI value. (*See* Appendix C, section 6.1.[13]) Consistency in the LCA analysis and in the regulatory process generally should require producers of sugarcane ethanol to account for those emissions in their applications, unless they can accurately and affirmatively show for purposes of their pathway application that no such backhaul emissions exist.[14]

LCFS 46-21

- *Accuracy of inputs for shipping emissions for Brazilian sugarcane ethanol.* Basic information used in the LCA analysis must be accurate. As Appendix C indicates, CA

LCFS 46-22

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[13] A screen-shot of the relevant workbook from CA GREET 2.0 is included as an Exhibit to these comments.

[14] If the premise for assigning no backhaul emissions for sugarcane ethanol from Brazill is a belief that vessels that would carry sugarcane ethanol to the United States from Brazil would not leave the United States without a cargo, then (barring some explanation) the same premise should apply to the water transport of renewable diesel from the Far East, corn ethanol produced and used in the United States after barge transport, sugarcane ethanol transported by barge, and other fuels transported by barge that are included in GREET 2.0.

LCFS 46-21 cont.

GREET 2.0 assumes that all sugarcane ethanol from Brazil is delivered in 22,000-ton shipments ─ an assumption that is not supported by the available data. (See Appendix C, section 6.2.) CA GREET 2.0's assumption likely understates GHG emissions from inbound ocean transport by 100 percent. CA GREET 2.0 also uses unrealistic, across-the-board assumptions about the relationship between oceangoing vessel power requirements and vessel speed. (*Id.*, section 6.4.) The appropriate course is to modify CA GREET to include default values based on the relevant real-world data (presented in Appendix C), which may be modified for pathways based on verifiable and enforceable certifications by the pathway applicant.

LCFS 46-22 cont.

Appendices B and C identify additional inconsistencies, errors and failures to use the best available information in CA GREET 2.0. Two of the world's leading biofuels experts, Bruce Dale and Seungdo Kim of Michigan State University, have identified additional errors in CA GREET 2.0 for corn ethanol, as documented in Appendix B. Such errors violate the Legislature's mandate for the use of the "best available" information in AB 32 regulations, and those errors were presented and fully documented to the CARB staff in November 2014, shortly after a draft of CA GREET 2.0 was released for public review. The impact on the direct CI emissions factors is significant, especially for corn-stover ethanol, and those errors must be addressed without further delay. Likewise, Appendix C indicates that CA GREET 2.0 does not reflect actual sugarcane farming practices, along with other errors that must also be corrected now, before the rulemaking proceeds further. (See Appendix C, sections 2-5.) Unless those errors are corrected, the new LCFS regulation will provide significantly inaccurate "signals" to downstream regulated parties, and will not maximize the program's goals in a cost-effective manner.

LCFS 46-23

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In sum, the CI values assigned to corn and sugarcane ethanol are not based on reliable data and methodologies, and need to be corrected before CARB tries to move forward with the LCFS "re-adoption" process. Although the CARB staff may believe that some or all the issues identified above cannot be addressed now, given their current regulatory schedule and claimed inadequate level of resources, the Board cannot accept such a position. The Board has discretion in setting the schedule to hear items for approval and to allocate CARB's resources, but under AB 32 it has no discretion to adopt or enforce regulations that are not based on the "best available economic and scientific information." Cal. Health & Safety Code § 38562(e). Again, applying CIs that are not based on the best available economic and scientific information threatens to undermine the very purpose of the LCFS.

LCFS 46-24

B. Impacts of the Current LCFS Proposal

The incorrect regulatory "signals" created by the CI values assigned to corn and sugarcane ethanol will skew the California renewable fuels market away from corn-starch ethanol, and toward sugarcane ethanol. Corn-starch ethanol will not be able to compete with sugarcane ethanol using scientifically unreliable CI values. Among other consequences, this means that the potential increase of 13 cents per gallon of liquid fuel in 2020, estimated by the CARB staff if LCFS credits cost $100 per credit, will not be spent to achieve reductions in the CI of California motor fuels in the most cost-effective manner possible and may not lead to GHG reductions at all.[15]

LCFS 46-25

[15] The CARB staff's 13-cent-per-gallon estimate appears in the Attachment to the Form 399 (Fiscal Impact) report signed on December 15 and 16, 2014, by two CARB staff members, and which Growth Energy located in the rulemaking file at CARB in early January 2015. CARB uses the $100 per credit estimate in the ISOR for the LCFS. *See* LCFS ISOR at VII-1. According to the ISOR, the estimated fuel price increase for gasoline in 2020 using the $100 per credit estimate is 12 cents per gallon. *See id*. at VII-5, Table VII-5. While the CARB staff calls the $100 per credit estimate "conservative," considers the 12-cent-per-gallon estimate to "represent the upper bound of fuel price impacts," and urges that its estimates not be used to "determine the impact of credit prices on the final retail price of transportation fuels," *see id*.,

Despite the lack of corollary benefits, the new LCFS regulation will result in the displacement of corn-starch ethanol produced in the Midwest with other fuels. The staff has published an "illustrative compliance scenario" which projects a reduction in corn ethanol use in California gasoline from the current (2014) level of 1,250 million gallons per year to 700 million gallons per year in 2020, with an increase in consumption of cane ethanol equal to about 64 percent of that reduction. That scenario means a reduction in the use of Midwest corn ethanol in California of about 550 million gallons per year as of 2020, relative to today, equivalent to the entire output of about seven typical-sized ethanol plants.[16]

The CARB staff has based its analysis of the economic impact of the LCFS regulation from 2016 to 2020 ─ which is an analysis that is mandatory for any rulemaking governed by the APA, and whose reliability must be affirmed by the rulemaking agency before a final rule can be adopted[17] ─ on estimates of the prices of LCFS credits from 2016 to 2020. The primary case used in CARB's economic impact analysis uses, as indicated above, a $100 per credit price; the staff's analysis also examines economic impacts using lower credit prices. As explained in Appendix D, if sugarcane ethanol pathways achieve CI levels of 40 g/MJ, and corn-starch ethanol pathways achieve CI levels of 70, credit prices as low as $23 would be sufficient to induce a switch from

LCFS 46-25 cont.

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the staff has not fully explained why it considers the $100 per credit to be "conservative" or why it believes the 12-cent-per-gallon increase to "represent the upper bound."

[16] According to data published by the Renewable Fuels Association, the average output of operating corn-starch ethanol biorefineries in the United Sates is about 76 million gallons of ethanol per year. *See* www.ethanolrfa.org/pages/statistics.

[17] *See* Cal. Gov't Code § 11346.5(a)(13) (requiring a determination of cost-effectiveness in an initial regulatory proposal); id. § 11346.9(a)(4)(same, in the Final Statement of Reasons for regulatory action). An agency cannot determine the cost-effectiveness of a regulation without estimating the costs of the regulation, as well as its benefits. As for the CARB staff's estimates of the benefits of the proposed new LCFS regulation, see Part IV below.

Midwest corn ethanol to imported sugarcane ethanol, assuming that the latter is available for sale to the downstream market in California. (That is an assumption that the CARB staff has made in its compliance and economic impact analyses.) As Appendix D, prepared by Edgeworth Economics, states, the CARB staff's "scenario indicating a substantial decline in the use of Midwest corn ethanol in California and an increase in the use of imported cane ethanol is therefore not only plausible, but probable if sufficient ethanol is available from Brazil, even at modest credit prices well below CARB's projected level of $100." CARB must explain whether, and if so, why, it considers this dramatic shift in the sourcing of ethanol for the California market (which its own staff's economic impact analysis confirms) to be irrelevant to its statutory mandates or objectives, and to the policies that it pursues as a matter of discretion.

LCFS 46-25 cont.

Much, if not all, of the Midwest corn ethanol eliminated from the California market would be ethanol produced at biorefineries that generate renewable fuel that is certified under the federal Renewable Fuel Standard (RFS) with the specific intent of reducing national greenhouse gas emissions, thereby putting the LCFS program into direct conflict with federal law and policy.[18] In addition to the economic impacts on corn-starch ethanol business operations, the U.S. corn-starch ethanol producers who are currently attempting to finance the development of cellulosic ethanol production capabilities at plants located in the United States may have fewer resources available for those development efforts; in that respect, the LCFS program will further interfere with the goals and purposes of federal biofuels law and policy, which include the commercialization of cellulosic ethanol. Unless there is a significant expansion in domestic demand for ethanol, the increased imports of Brazilian cane ethanol, combined with the proposed LCFS regulation's

LCFS 46-26

LCFS 46-27

[18] 42 U.S.C. 7545(o)(2)(A)(i)

LCFS 46-26 cont.

generous allowance of credit to California electric utilities,[19] will result in a combination of (i) lost production or even shutdowns at Midwest biorefineries, and (ii) increased logistics costs as those American biorefineries seek foreign markets (potentially, and ironically, in Brazil, where ethanol is not subject to the LCFS regulation). If the Board believes that any other outcome or combinations of outcomes for the Midwest corn ethanol industry from the LCFS regulation will occur, it should explain them and estimate their likelihood of occurrence.[20]

LCFS 46-27 cont.

The second outcome ─ corn ethanol export outside the United States to make up volume lost in California ─ will not produce reductions in global GHG emissions.[21] To the extent the first outcome (loss of any commercially practicable way to offset the reductions in California demand) occurs, then the LCFS regulation will have particularly grim consequences for the Midwest corn ethanol industry and those who depend on it. As Appendix D indicates:

> On average, U.S. corn ethanol facilities employ approximately 0.8 employees per million gallons of ethanol produced, or about 61 employees for a typical plant. A reduction in ethanol demand of 550 million gallons per year therefore would result in a direct loss of approximately 440 jobs at ethanol refineries. In addition to these direct effects, the regions that host ethanol production facilities would experience additional reductions in economic activity stemming from reduced purchases of locally-sourced inputs (the "indirect" impact) and reduced spending by facility employees and local vendors (the "induced" impact). These additional economic impacts are generated by the "multiplier" effect, which results from the recycling of business revenues and household income within the local region. Plausible estimates for the overall multiplier effect for employment applicable to the ethanol industry range from about 2 (indicating a total impact on employment equal to two

LCFS 46-28

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[19] *See* Section C below.

[20] Note that this analysis of potential outcomes from the LCFS regulation assumes for present purposes that corn-starch ethanol pathways achieve the CI levels projected by the CARB staff. As to the realism of those projected reductions in CI levels, see Part III.A below.

LCFS 46-27 cont.

[21] In addition to producing no net GHG emissions reductions, the second outcome will impose substantial direct costs on the Midwest corn ethanol industry. Appendix D estimates that the additional logistics costs for the transport of Midwest corn ethanol to a market like Brazil at approximately 10 cents per gallon.

LCFS 46-28 cont.

> times the direct employment impact) to about 7. Applying a figure of 4 to the direct employment impacts calculated above implies a loss of approximately 1,760 jobs in ethanol producing regions.

If CARB disagrees with that assessment or considers those outcomes to be irrelevant to its mission, the Board needs explain why those impacts in the Midwest are overstated, or why those impacts are irrelevant.

LCFS 46-28 cont.

III. ENVIRONMENTAL ANALYSIS

Two different statutes ─ AB 32 and CEQA ─ make it critical for the Board to develop a complete understanding of the environmental issues presented by the CARB staff's ADF and LCFS proposals. First and foremost, the purpose of AB 32 is to reduce GHG emissions, *see, e.g.*, Cal. Health & Safety Code § 38562(a); regulations that do not reduce GHG emissions are not "necessary" to meet the purposes of AB 32 and would violate the Government Code.[22] In addition, among other relevant requirements, including the obligation to rely on the "best available" scientific and economic information, *id.* §38562(e), AB 32 directs that to the extent feasible, the Board's GHG regulations not interfere with efforts to meet and maintain federal and state air quality standards. *See id*. § 38562(b)(4). Under CEQA and the Board's implementing regulations, the Board's obligations to protect the environment are, if anything, even more exacting: CARB "shall not" adopt or approve any action "for which significant adverse environmental impacts have been identified during the review process." if there are "feasible mitigation measures or feasible alternatives available which would substantially reduce such adverse impact." 17 C.C.R. § 60006.

LCFS 46-29

LCFS 46-30

As explained below, the CARB staff's two proposals do not meet the criteria of either AB 32, or of CEQA and the Board's implementing regulations. First, the CARB staff's LCFS proposal

LCFS 46-31

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[22] *See* Cal. Gov't Code § 11342.2 ("no regulation adopted is valid or effective unless … reasonably necessary to effectuate the purpose of the statute").

assumes that the current LCFS regulations have actually reduced net GHG emissions into the atmosphere; in fact, there is no evidence that the LCFS regulations have done so, to date, and the available evidence demonstrates that there have been no such GHG reductions. Second, and building its first false premise about the efficacy of the current LCFS program, the staff's LCFS proposal invites a further assumption that the new LCFS regulations will achieve further reductions in net GHG emissions, but remarkably, the *staff has offered no definitive quantitative estimate of those GHG reductions.* That proposal also makes unrealistic assumptions about how portions of the affected industries will respond to the new regulation, and fails to account for ways in which the new regulation will increase, rather than decrease, GHG emissions, as well as criteria pollutants. The proposed new LCFS regulation cannot properly be treated as a regulation that meets the purposes of AB 32 because there is no reliable demonstration that the regulation will reduce GHG emissions, and the proposal is therefore not authorized by AB 32 and is invalid under the Government Code. In addition, and in conflict with section 38562(b)(4) of the Health & Safety Code, the CARB staff has ignored alternative, "feasible" methods of obtaining the same GHG reductions that it once attributed to the LCFS regulation through 2020. (*Id*.)

LCFS 46-31 cont.

LCFS 46-32

LCFS 46-33

LCFS 46-34

The staff's two proposals (for the new ADF regulation and for the revised LCFS regulation) also conflict with the requirements of CEQA and cannot be adopted. CARB is obligated to mitigate the significant adverse environmental impacts of the LCFS regulation recognized by the Court of Appeal in *POET v. California Air Resources Bd*. (2013) 218 Cal. App. 4th 681, that will result from the use of biodiesel fuels. As explained in Appendices I and J and as summarized below, the CARB staff's two proposals and the draft EA do not properly mitigate those impacts, or comply in other important respects with CEQA and the Board's implementing regulations.

LCFS 46-35

A. The LCFS Regulation and GHG Emissions

We begin with the facts and analysis that are pertinent to an analysis of the LCFS proposal under AB 32, before turning to the CEQA analysis.

1. Background on Corn-Starch Ethanol Production: Past and Current Practices

The first step in understanding the environmental consequences of the proposed new LCFS regulation relevant to AB 32 is to consider the impacts of the current regulation, first adopted under AB 32 in 2009. The ISOR for the new proposed LCFS regulation claims that "[o]ver the first three years of the LCFS, there has been a steady decline in the average CI of the mix of biofuels used in California. Concurrently, there has been a great expansion of the applications for fuel-pathway CIs." (LCFS ISOR, App. B at B30.) On that basis, the "ARB staff expects these trends to continue and actually accelerate as the stringency of the LCFS increases and credits become more valuable." (*Id*.) The ISOR cites no facts in support of the staff's expectation, and its claim that there has been a "steady decline in the average CI of the mix of biofuels sold in California" is contradicted by the relevant evidence from the corn-starch ethanol industry. These are the pertinent facts: [23]

LCFS 46-36

1. Ethanol produced from corn starch is the principal renewable fuel produced in the United States, and has been the primary alternative fuel blended into gasoline in California, both before and after the implementation of the current LCFS regulation. Members of Growth Energy and other producers in the U.S. corn ethanol industry have strong commercial incentives to

LCFS 46-37

[23] Because Growth Energy does not have access to confidential business information of its members or any other firms in the ethanol industry, it bases these comments on information in the public record. *See* Appendix E (Declaration of Erin Heupel, P.E. (hereinafter "Heupel Decl.").

maximize yield from the feedstock they purchase and to minimize energy usage, and thus to minimize GHG emissions. Next to corn costs, energy costs are the largest variable cost in producing corn ethanol.

2. A corn-starch ethanol plant costs millions of dollars to build. Most corn-starch ethanol is produced in the Midwest, at plants that are carefully sited in order to have ready access to their feedstock, as well as competitively priced natural gas, electricity, or other sources of energy to run the plant. Ethanol plants cannot directly control and document how farmers grow and harvest corn, which the farmers grow not only to sell to ethanol plants, but also to other customers, on the best possible commercial terms for the farmers. The companies that survive and prosper in the corn ethanol industry are those whose plants are designed from the beginning for maximum efficiency in feedstock conversion and minimum energy consumption.

3. The competitive pressure to reduce energy consumption, and not regulation, is what drives reductions in GHG emissions at corn ethanol biorefineries. For example, the current LCFS regulation has been in full effect since 2011; based on the information in the public record available to Growth Energy, ***no biorefinery*** selling ethanol for blending into gasoline has made ***any*** significant changes in its production methods, feedstocks, methods of transport, or any other factor relevant to GHG emissions, in order to specifically obtain a lower CI value for purposes of the California LCFS regulation. To be sure, as the ISOR claims, numerous plants have obtained approval for plant-specific "pathways" with lower CI values than might have otherwise been assigned to them under the California regulation. Those facilities, however, have obtained approval for those pathways by documenting production methods adopted for competitive reasons and federal policy reasons, completely independent of the California LCFS regulation.

LCFS 46-37 cont.

Thus, when the ISOR claims that there has been a "great expansion" in the number of applications for new alternative-fuels pathways, in the case of Midwest corn-starch ethanol plants, it is confusing what are essentially paperwork exercises ─ when applicants are documenting production processes, methods and energy sources that have been adopted for commercial reasons ─ with reductions in CI levels driven by regulation. Because the record of "great expansion" in pathway applications appears to be one of the principal bases for predicting that the new LCFS regulation will result in reductions in the future, it is important for the CARB staff, and ultimately the Board, to identify any evidence that contradicts what Growth Energy has concluded from the information available in the open record.[24] Any such evidence should be then be placed in the rulemaking file pursuant to section 11347.1 of the Government Code for public review and comment. If, on the other hand, the CARB staff has no evidence the current LCFS regulation has driven reductions in the CI levels of corn ethanol plants in the Midwest, and the Board decides to act in reliance on the staff's speculation, then candor should require the Board to admit as much before work is completed on the new regulation.

LCFS 46-37 cont.

Of course, not all corn-starch ethanol plants that were able to participate in the California market before 2011 have been able to remain in that market, because not all such plants have been able to document production processes, methods and energy usage that would qualify them for competitive CI values. When they have been able to remain in the market, they must generally

LCFS 46-38

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[24] As Appendix E indicates, Ms. Heupel of POET LLC, for her part, was able to describe the business and regulatory practice at her company in the open record. If the CARB staff believes that it cannot put any information that corroborates its position owing to concerns about business confidentiality, and that contradicts Growth Energy's understanding of how corn starch ethanol biorefineries have gained lower-CI pathways to date, it should so indicate, and include a description of its efforts to obtain permission from the owners of the putatively confidential information in the open record.

LCFS 46-39

sell their product for less than what plants with lower CI values can obtain.[25] The CARB staff has admitted as much.[26] " Some of the plants that could not document the production technologies, processes, methods, and energy inputs that the CARB staff would reward with lower CI values had previously sold a substantial volume of ethanol in California," as one industry participant has stated, and "[t]he LCFS regulation forced some of those plants entirely out of the California market."[27] As the same industry participant has explained:

LCFS 46-38 cont.

> The effect of the LCFS regulation has been to "de-commoditize" the corn ethanol market, for purposes of California -- *i.e.*, ethanol is no longer a fully fungible commodity in California, in which producers can prevail by offering the best commercial terms. Plants that were optimized for shipment of ethanol to California when they were built, but that can no longer sell their ethanol in California, now must find buyers outside California. On an industry-wide basis, the LCFS regulation has led to "fuel shuffling" that has likely increased the number of miles that Midwest corn ethanol had to travel in 2011 in order to get from the production facilities to customer destinations.

LCFS 46-40

Whiteman Decl. ¶ 18. Importantly, as that individual concludes:

> For all the disruptions in the California ethanol market created by the LCFS regulation, there has been no reduction in the overall amount of corn ethanol produced in the United States, or used as a motor fuel in this country or overseas. …. The overall production levels for corn ethanol last year, and for the foreseeable future, depend on macroeconomic factors (including demand for gasoline) that are independent of the LCFS regulation.

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[25] Growth Energy relies here on other public information. *See* Appendix E (Declaration of Robert Whiteman (hereinafter "Whiteman Decl.").

[26] *See* Whiteman Decl. ¶ 17. Mr. Whiteman is a senior official in one of the largest ethanol marketing businesses in the United States, and would qualify as an expert on corn-starch ethanol marketing based on his knowledge, skill, experience and training.

[27] *Ibid.*

Id. ¶ 20.[28] The CARB staff also agreed, in the 2009 rulemaking, that "fuel shuffling" would be one result of the current LCFS regulation. When taken together, the totality of the evidence thus establishes this important point: ***the current LCFS regulation has not resulted in any reductions in GHG emissions from corn starch ethanol,*** whose use in gasoline has been the downstream fuel industry's principal method of complying with the LCFS regulation.

LCFS 46-40 cont.

In sum, and contrary to what may be the position taken in the ISOR for the new regulatory proposal, there has to date been no "real" reduction, see Cal. Health & Safety Code § 38562(d)(1), in the "average CI in the mix of biofuels used in California," at least with respect to liquid biofuels used in gasoline. Here again, if the CARB staff has any actual evidence contradicting Growth Energy's understanding of how the LCFS regulation has affected the corn-starch ethanol business to date, it must provide that evidence for review under the Government Code, or instead admit that it is asking the Board to rely on unsupported opinion.

LCFS 46-41

2. Prospects for Future Reductions in the Carbon Intensity of Corn-Starch Ethanol

The ISOR also claims that the new LCFS regulation will continue the "trend" towards lower CI levels "as the stringency of the LCFS increases and credits become more valuable." (LCFS ISOR, App. B at B30.) The ISOR continues as follows:

> A two-step process was used to reflect how the trend to lower CI fuels will impact credit generation between 2016 and 2025. First, estimates of "pool-average" CIs for fuels with many different pathways were made based on the range of fuel-pathway CIs (FPCs) approved for use. The fuels studied were corn ethanol (150 FPCs), Cane Ethanol (21 FPCs), and Corn-Sorghum Ethanol (20 FPCs). In each case, the CIs of the lowest 50 percent of FPC CIs were averaged together, and this CI was then assigned (after appropriate adjustments to reflect iLUC changes) as the CI of that fuel category in 2016. Once a starting point for a fuel category's CI was determined for 2016, the CI was further lowered to reflect that higher credit values and continued plant improvements will lead to lower average CI with time. A

LCFS 46-42

[28] Mr. Whiteman prepared his Declaration in 2012.

> conservative adjustment of a one percent decrease in CI values for each category was uniformly applied to at least partially recognize this effect.

Id. at B30-31. As the ISOR adds in a footnote, "For example the average CI of corn-derived ethanol under this method changes from 82.2 grams/MJ to 70.0 grams/MJ." Significantly, the ISOR here concedes that a substantial part of the industry current serving California ─ some or all producers who are in the upper half of the current FPC distribution ─ have no future in the California market. Also significantly, the ISOR offers no technical analysis or informed expert opinion to support the speculation that remaining ethanol production processes will achieve *on average* the first lower-CI level (for corn ethanol, 70.0 grams/MJ), and then year-over-year reductions.

LCFS 46-42 cont.

In addition to lacking any apparent support, other than speculation by the authors of the ISOR, the ISOR's prediction for the future cannot be squared with what is currently known about industry conditions and the requirements of the proposed new LCFS regulation. As noted above (*see* Part II.B) and explained in Appendix D, at relatively modest LCFS credit prices, the LCFS regulation will shift demand for ethanol from corn-starch pathways to sugarcane pathways, and that shift will occur in the first year of the new program (2016). Here are some of the key facts that the ISOR's speculation about future "trends" does not address:

LCFS 46-43

- The U.S. corn ethanol industry currently has enough production capacity to serve the Nation. The most competitive Midwest corn ethanol plants in operation today are built and sited for optimal logistics and energy usage in the first years of production, and not for significant future optimization.[29]
- In addition to energy, the corn feedstock is a major cost factor in corn-starch ethanol production, and corn-starch ethanol plants "cannot directly control and document how

[29] See Appendix E (Heupel Decl.).

farmers grow and harvest corn, which the farmers grow not only to sell to ethanol plants, but also to other customers, on the best possible commercial terms for the farmer."[30]

- Corn-starch ethanol plants are also assigned by the LCFS a large ILUC emissions factor, which they are powerless to change.

- Corn-starch ethanol plants can therefore work with only a fraction of their production processes — chiefly, energy, for which they are already likely optimized — to achieve lower CI scores.

- Any costs incurred to reduce the CI score of the ethanol that corn ethanol plants would produce would have to be recovered in the California market against competition from sugarcane ethanol and electricity. The deeper the reductions in CI, assuming any such reductions were possible, the greater the costs, and the longer the period needed to remain competitive in California.

Against that backdrop, Growth Energy credits the opinion expressed in Appendix E that in order to remain in the California market, "even a very efficient Midwest corn ethanol plant would have to find and implement further efficiencies or energy reduction opportunities not driven by the nationwide market and recover the costs of the necessary changes, over a very short time frame.… Rather than incur those costs, U.S. corn ethanol plants will try to compete in markets outside California."[31] Here again, if the CARB staff has any basis either to disagree with the prediction of market exist, or to support its belief in the "trend" that the ISOR predicts, it needs to provide the information (be it facts, expert opinion, or any other type of evidence) for public comment. If the CARB staff cannot do so, then as indicated above, candor requires the Board to admit that the predicted future operation of the LCFS regulation in the ISOR is based on unsupported conjecture, at least with respect to corn-starch ethanol.

LCFS 46-43 cont.

[30] Heupel Decl. ¶ 10.

[31] *Id.* ¶ 11.

This issue — how the new LCFS regulation will affect the supply of cornstarch ethanol to California — needs to be addressed clearly, directly, and empirically. Corn starch ethanol remains a part of the CARB staff's compliance scenarios for many years; if corn starch ethanol cannot meet the expectations of the ISOR, then the viability of the new LCFS program as depicted in the ISOR is in serious jeopardy. If the absence of the corn starch ethanol from the California market triggers use of the cost-containment provision, as the costs of LCFS credits skyrockets, then LCFS program will not achieve the GHG reductions that CARB might otherwise attribute to the program.

LCFS 46-43 cont.

3. Greenhouse Gas Emissions and Related Impacts of the New LCFS Regulation

Despite the ejection of corn-starch ethanol from the California renewable fuels market, the new LCFS regulation will not reduce, and will likely increase, net global GHG. As explained above, "fuel shuffling" is one likely outcome of the new LCFS regulation (accompanied by potential shutdowns of biorefineries in the Midwest). To date, the fuel shuffling caused by the LCFS regulation has been confined, in the case of ethanol, to the continental United States. The new LCFS regulation will make fuel shuffling an intercontinental phenomenon, as California begins to draw sugarcane ethanol in large quantities from production sites in Brazil. As explained in Appendix G, one result of the new regulation will be increases in GHG emissions caused by the transport of large volumes of Brazilian sugarcane ethanol to the California market. Looking solely at the GHG emissions increases that should be attributed to oceangoing tankers, fuel shuffling emissions will fall in the range of 385,000 to 735,000 tons of GHG emissions per year, under the assumptions described in Appendix G.[32] If the CARB staff or the Board have any disagreement with those estimated GHG shuffling losses, it should explain them and their basis.

LCFS 46-44

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[32] *See* Appendix G. Those estimates are based on necessary corrections to the CA GREET 2.0 model, described in Appendix C. Even if those corrections are not made, GHG emissions from

For its own part, the CARB staff apparently has no current estimate of the net GHG emissions impacts of the LCFS regulation ─ at least, none that it was prepared to publish. The ISOR contains a table (Table IV-2) that contains some estimates of "Projected LCFS GHG Emissions Reductions." The ISOR prefaces that table, however, with this important qualification:

> These estimates do not include a reduction to eliminate the double counting of the Zero Emission Vehicle Mandate, the federal Renewable Fuel Standard Program, the Pavley standards, or the federal Corporate Average Fuel Economy Program. (LCFS ISOR at IV-2)

LCFS 46-45

That is a breathtaking admission. Growth Energy is not aware of any other major regulation that the Board has ever been asked to approve without a net emissions reduction estimate for the pollutant or substance of primary concern (here, GHG emissions). For all that the Board and the public can tell, the programs that the ISOR has failed to include would leave the LCFS program with *de minimus* GHG emissions reduction benefits. Certainly, the current analysis before the Board does not meet the most basic tests for regulatory approval under AB 32; the GHG reductions that the proposed new LCFS regulation are not "quantifiable." Cal. Health & Safety Code § 38562(d)(1). Nor, of course, can the Board claim that the LCFS regulation would be "cost-effective," *see id.* § 38562(a), because there are no quantified GHG emissions reductions benefits to be placed into a ratio with the costs of the proposal. CARB cannot approve the new LCFS program proposed in the ISOR, without contorting the statutory language to allow it to impose costs on the public without first quantifying the GHG reduction benefits for which the public must pay.

LCFS 46-46

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the transport of sugarcane ethanol by oceangoing tankers will rise by approximately 150,000 tons per year. *Id*. at 1.

There is no escaping the requirements of the rulemaking provisions in AB 32, and certainly none in other parts of the statute. AB 32 begins with legislative findings about the importance of addressing global warming, and urges coordination of California regulatory efforts with those of other jurisdictions. *See* Cal. Health & Safety Code § 38501(a),(b),(c),(f). Yet even if GHG reductions from the new LCFS program could be quantified, those reductions were assumed to be substantial, and they were assumed to extend nationwide ─ in other words, if every goal suggested by the statute's legislative findings were fulfilled ─ the end result would produce no appreciable effect on global warming. As explained in Appendix H, the difference in ambient temperatures could barely be resolved (in the third decimal place) by 2050, using the generally-accepted modelling system developed to assess the impacts of policies on global temperatures, and would be too small to be measured in the real world. In the 2009 LCFS rulemaking the CARB staff acknowledged this point, and suggested that the benefit to the LCFS program as a means of addressing climate change would lie in the export of the regulation outside California. Appendix H demonstrates that even under such an assumption, the LCFS program would not produce changes in the global climate. The LCFS program neither conforms with the rulemaking requirements of AB 32 nor serves the statute's highest aspirations.[33]

LCFS 46-47

B. California Environmental Quality Act ("CEQA") Analysis

The core of Growth Energy's CEQA comments on the LCFS and ADF regulations is contained in Appendix I and its attachments, in Appendix J, and the other appendices specifically

LCFS 46-48

[33] These observations on the lack of any change in the global climate resulting from the new LCFS program should not be taken to indicate that any regulation adopted under color of AB 32 could ever be exempt from the specific rulemaking requirements in section 38562 and other provisions of AB 32 that limit and specify CARB's authority.

referenced therein. The Board is required to consider detailed responses by the staff to each part of the Growth Energy's CEQA comments.[34]

LCFS 46-48 cont.

1. Impacts of the Proposed Regulations on Criteria Pollutants

The ISOR for the ADF regulation estimates that the biodiesel use allowed by the ADF regulation, which will occur as part of efforts to comply with the LCFS regulation, will increase emissions of oxides of nitrogen ("NOx") by 1.35 tons per day in 2014 and according to the ISOR, will drop to 0.01 ton per day by 2023. Here are some of the salient problems in the ISOR for the ADF regulation and in CARB's draft EA, as explained in Appendix I and its attachments:

ADF 17-2

- The ISOR and its related documents do not describe the total diesel NOx emissions inventory on which the assessment is based. — ADF 17-3
- The CARB staff has erroneously concluded that the use of biodiesel in "New Technology Diesel Engines (NTDEs)" equipped with exhaust aftertreatment devices to lower NOx emissions will not lead to increased NOx emissions. The CARB staff has also incorrectly apply ratios of on-road vehicle travel by NTDEs from the now obsolete EMFAC2011 model to account for the amount of biodiesel used in all NTDEs including those found in non-road equipment. — ADF 17-4
- The CARB staff has incorrectly subtracted NOx reductions from the use of "renewable diesel fuel" from increases in NOx increases from biodiesel when assessing the environmental impact of ADF regulation. — ADF 17-5
- A conservative but reliable assessment of the NOx emission impacts of biodiesel use under the ADF that uses the latest CARB emissions models and corrects the flaws in the staff analysis has been performed for Growth Energy and is summarized in Appendix I (Lyons). The results of that assessment indicate that NOx increases from biodiesel will be much larger than those estimated by CARB staff and that the magnitude of the impacts will not decline as forecast by CARB staff. — ADF 17-6
- In addition, the assessment performed for Growth Energy demonstrates that the ADF regulation will lead to significant increases in NOx emissions in the South Coast and San Joaquin Valley air basins which are already in extreme non-attainment of the federal ozone NAAQS and moderate non-attainment of the federal fine particulate NAAQS. — ADF 17-7

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[34] *See* 17 C.C.R. § 6007(a)

- Inconsistencies and conflicts in the treatment of diesel and biodiesel fuels in the ADF and LCFS regulations create the potential for biodiesel blends to actually contain as much as 5 percent more biodiesel by volume than will be reported to CARB under the ADF regulation.

ADF 17-8

- Other errors in the CARB staff's environmental assessment include incorrectly selecting 2014 as the baseline year for the environmental analysis, a lack of documentation and use of unsupported assumption in determination of the NOx control level for biodiesel, and an unnecessary delay in the effective date for the implementation of mitigation requirements under the ADF regulation.

ADF 17-9

- Last year, during the development of the ADF and LCFS regulations, the CARB staff declined to adopt a proposed alternative to the ADF regulation submitted by Growth Energy. Given that the Growth Energy alternative was designed to mitigate all potential increases in NOx emissions, it yielded greater and more timely environmental benefits than the staff proposal. The Growth Energy alternative would have required the same mitigation methods as the ADF proposal but simply expanded the circumstances under which those methods must be applied; Growth Energy's proposal had a cost-effectiveness equal to that of ADF proposal.

LCFS 46-49
ADF 17-10

2. CARB's Certified CEQA Program

CARB's certified program under CEQA does not excuse it from its obligations to address those serious deficiencies in the ADF proposal and the draft EA. Although "[e]nvironmental review documents prepared by certified programs," such as that adopted by CARB, "may be used instead of environmental documents that CEQA would otherwise require," "[c]ertified regulatory programs remain subject . . . to other CEQA requirements." *City of Arcadia v. SWRCB* (2006) 135 Cal.App.4th 1392, 1421-22. CEQA documents prepared under certified regulatory programs are considered to be the "functional equivalent" of the documents CEQA would otherwise require. *Mountain Lion Found. v. Fish & Game Comm.* (1997) 16 Cal.4th 105, 113.

LCFS 46-50

Agencies with qualifying certified regulatory programs are excused only from complying with the requirements found in Chapters 3 and 4 of CEQA (*i.e.*, Pub. Res. Code, §§ 21100-21154) in addition to Public Resources Code § 21167. Pub. Res. Code, § 21080.5, subd. (c). "When conducting its environmental review and preparing its documentation," however, "a certified

LCFS 46-51

regulatory program is subject to the broad policy goals and substantive standards of CEQA."[35] The CEQA Guidelines implementing section 21080.5 provide that, "[i]n a certified program, an environmental document used as a substitute for an EIR must include '[a]lternatives to the activity and mitigation measures to avoid or reduce any significant or potentially significant effects that the project might have on the environment.'" (*City of Arcadia, supra*, 135 Cal.App.4th at 1422 [quoting CEQA Guidelines, § 15252(a)(2)(A)]. CARB's functional equivalent document is the "staff report," which "shall be prepared and published by the staff of the state board." 17 C.C.R., § 60005(a).[36] The regulations require the staff report to be "published at least 45 days before the date of the public hearing" on the rulemaking, and to "be available for public review and comment." (*Id.*) Staff reports must be prepared "in a manner consistent" "with the goals and policies of" CEQA, and "shall contain":

> a description of the proposed action, an assessment of anticipated significant long or short term adverse and beneficial environmental impacts associated with the proposed action and a succinct analysis of those impacts. The analysis shall address feasible mitigation measures and feasible alternatives . . . which would substantially reduce any significant adverse impact identified.

17 C.C.R. § 60005(b).

The regulations also provide that an action "for which significant adverse environmental impacts have been identified during the review process shall ***not*** be approved or adopted as

LCFS 46-51 cont.

LCFS 46-52

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[35] Kostka & Zischke, *Practice Under Cal. Env. Quality Act* (2005) § 21.10] ["Kostka & Zischke"] [citing *City of Arcadia, supra*, 135 Cal.App.4th at 1422; *Sierra Club v. State Bd. of Forestry* (1994) 7 Cal.4th 1215; *Californians for Native Salmon & Steelhead Ass'n v. Dept. of Forestry* (1990) 221 Cal.App.3d 1419; *Envt'l Protection Info. Ctr. v. Johnson* (1985) 170 Cal.App.3d 604, 616].)

[36] In this case, CARB's staff report is accompanied by a draft EA.

proposed if there are feasible mitigation measures or feasible alternatives available which would substantially reduce such adverse impact." *Id*. § 60006. "Feasible" means "capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors, and consistent with the state board's legislatively mandated responsibilities and duties." *Id*) If CARB receives comments raising "significant environmental issues associated with the proposed action," staff must "summarize and respond to the comments either orally or in a supplemental written report. Prior to taking final action on any proposal for which significant environmental issues have been raised, the decision maker shall approve a written response to each such issue." *Id*. § 60007.

LCFS 46-52 cont.

3. CEQA Analysis

Turning to the merits of CARB's current environmental analysis, and as explained in Appendix J, the draft EA does not comply with CEQA in several material respects.

LCFS 46-53

First, the draft EA fails to consider the significant environmental effects associated with the version of the LCFS regulation currently in effect. Although the proposed LCFS regulation is nearly identical in structure to the current LCFS regulation, the draft EA fails to describe or identify impacts associated with the whole of the "project" under CEQA by ignoring recognized significant impacts associated with the existing regulation. Ignoring such impacts is inconsistent with the writ issued by the superior court in *POET, LLC v. California Air Resources Board* (2013) 218 Cal.App.4th 681 ("*POET*"), and results in a vague and incomplete project description. The draft EA also fails to state what environmental baseline is being used in its analysis, although the substantive discussions in the EA suggest a baseline of 2014 is being used. A 2014 baseline is inconsistent with Section 15125(a) of the CEQA Guidelines because it does not accurately reflect when CARB commenced its environmental review of the LCFS regulations (2007), and obscures the amount of NOx emissions caused by the increased usage of biodiesel resulting from the LCFS

LCFS 46-54

LCFS 46-55

regulation. And even if CARB were able to credibly argue the current LCFS regulation is a different "project" than the nearly identical LCFS regulation proposed for "re-adoption," (1) analysis of pre-2014 impacts would nevertheless be required as "cumulative impacts," and (2) any attempt to ignore prior impacts would constitute impermissible piecemealing or segmentation of environmental review.[37]

LCFS 46-55 cont.

The draft EA's analysis of criteria pollutant emissions caused by the proposed regulations is also incomplete. The draft EA fails to analyze or discuss emissions of any criteria pollutants, other than NOx. But even the discussion of impacts associated with NOx emissions, however, is misleading and fails to consider additional NOx emissions caused by increased biodiesel usage. CARB cannot argue increased renewable diesel fuel usage will offset NOx increases associated with biodiesel. This increase is speculative, and there is no mitigation, legally-binding requirement, or other performance standard to ensure those offsets will occur. The draft EA's analysis of criteria pollutant emissions is also incomplete because fails to analyze known sources of NOx emissions, including emissions associated with biodiesel use in "New Technology Diesel Engines" (NTDEs). Notably, if a more credible analysis of NOx increases using generally accepted techniques is employed, estimated NOx emissions are calculated to be far more severe than that disclosed in the draft EA, and could total as much as 9.73 tons per day statewide in 2020, and 2.39 tons per day (or 872.35 tons per year) in 2020 in the San Joaquin Valley air basin alone. This figure is vastly higher than the 10 tons per year threshold of significant adopted by the San Joaquin Valley Air Pollution Control District for projects under CEQA, and results in emissions

LCFS 46-56

LCFS 46-57

LCFS 46-58

[37] The two regulations under consideration are also internally inconsistent, as Appendix I explains. To avoid an unstable and inaccurate project description, and to avoid additional NOx impacts associated these inconsistencies (including but not limited to the blending of "Alternative diesel fuel" mixed with "CARB diesel"), the regulations must be revised and reconciled.

that directly violate the mandate of AB32. Cal. Health & Safety Code, §§ 38562 (b)(4), 38570 (b).

LCFS 46-58 cont.

The draft EA also recognizes the proposed LCFS regulation would result in the construction of new or modified facilities to meet demand for fuels created by the regulations, including processing plants for agriculture-based ethanol, cellulosic ethanol, and biomethane. The draft EA, however, only generally describes the impacts associated with this increase in develop, although it is feasible to calculate the projected additional emissions associated with such development. Although the draft EA performs no analysis of the impacts associated with these facilities, it finds the impacts to be significant and unavoidable. This is impermissible; a lead agency cannot simply label an impact "significant and unavoidable" without first providing a discussion and analysis. *Berkeley Keep Jets Over the Bay Comm. v. Bd. of Port Comm'rs* (2001) 91 Cal.App.4th 1344, 1370.

LCFS 46-59

The failure to quantify the impacts associated with such new construction also violates CEQA because it forecloses mitigation. If the impacts were quantified, CARB could meaningfully explore ways to develop mitigation to reduce such impacts or modify the regulation to reduce those impacts. Instead, the draft EA merely sets forth "recognized practices" that are "routinely required" to avoid or minimize impacts, without requiring the implementation of any specific measure, or even evaluating whether any such measures – if incorporated – would actually reduce or minimize the impact. This is improper under CEQA because the proposed mitigation measures are not required or otherwise enforceable, there is no discussion as to the efficacy of any measure, there is no quantification of the benefits associated with any measure, and the specific mitigation to be employed is deferred to a later time.

LCFS-46-60

The draft EA also fails to identify and analyze environmental impacts associated with fuel shuffling, which CARB has elsewhere recognized as a reasonably foreseeable consequence of the LCFS regulation. For one component of the LCFS regulation – shuffling of ethanol alone by ship – shuffling would result in at least an additional 150,000 tons per year of CO2 equivalent emissions using CARB's own models, and an additional 385,000-735,000 tons per year using more accurate models. These figures do not even take into account ethanol shuffling by other modes of transportation, or crude oil shuffling. There is likewise no analysis as to whether fuel shuffling would result in increases in criteria pollutants either in-state or out-of-state.

LCFS 46-61

The draft EA also fails to adequately analyze project alternatives. For example, the draft EA rejects the Growth Energy alternative, even though the alternative would significantly reduce NOx emissions associated with biodiesel. The draft EA also impermissibly rejects consideration of a Cap & Trade Alternative, even though that alternative would result in none of the numerous impacts the EA found to be significant and unavoidable. The CEQA Guidelines specifically recognize that comments raised by members of the public on an environmental document are particularly helpful if they suggest "additional specific alternatives . . . that would provide better ways to avoid or mitigate the significant environmental effects," CEQA Guidelines, § 15204, and CARB may not limit its project objectives in a way to foreclose consideration of any and all projects, with the exception of the project under consideration. It was exactly this type of pre-judgment that the Court of Appeal warned against in the *POET* decision in its discussion of *post hoc* environmental review, and impermissible delegation of environmental review authority.

LCFS 46-62

In sum, CEQA places the burden of environmental investigation on government rather than the public," and the draft EA falls well short of a complete and accurate investigation of the environmental effects of the proposed regulations. *Sundstrom v. County of Mendocino* (1988) 202

LCFS 46-63

Cal.App.3d 296, 311. As a result of these failures, the EA must be revised substantially, and recirculated for public review, prior to CARB's consideration of the proposed regulations for adoption.

LCFS 46-63 cont.

IV. THE BOARD'S GOVERNMENT CODE AND RELATED OBLIGATIONS

Addressing the deficiencies in the draft EA and the CARB staff's related environmental materials identified in Part III above and in Appendices I and J will require significant time and resources, if the Board decides to proceed with rulemaking based on the currently proposed regulations. Simultaneously with that effort, the Board also needs to consider whether there are less burdensome alternatives to the current staff proposals, as the Government Code requires, and also address serious problems in the transparency of the current rulemaking process. CARB's tasks under CEQA and the Government Code substantially overlap, because Growth Energy has proposed an alternative to the current LCFS regulation that would eliminate the need for NOx mitigation and thus greatly simplify the CEQA effort, while also reducing the costs and burdens of attaining the identified goals of AB 32.

LCFS 46-64

A. The Analysis of Alternatives under the Government Code

The Legislature regularly gives California administrative agencies wide discretion in achieving the purposes of the statutes it enacts, but it also requires that agencies avoid unnecessary or unduly burdensome regulation. Agencies cannot first propose regulations unless they have determined that no alternative to their own proposal would be "as effective and less burdensome to affected private persons and equally effective in implementing the statutory purpose or other provision of law." *See* Cal. Gov't Code § 11346.5(a)(13). Nor can an agency finally adopt its own proposal unless it can properly affirm and explain, with "supporting information," that "no alternative" that it has considered "would be more effective and less burdensome to affected

private persons than the adopted regulation, or would be more cost effective to affected private persons and equally effective" in meeting a legislative objective. *Id.* § 11346.9(a)(4).

There is no question that the proposed LCFS and ADF will impose costs on "private persons" and businesses in California, of as much as 13 cents per gallon by 2020, depending on the costs of LCFS credits. (*See* Part II.B above.) Growth Energy responded to the staff's call in the spring and summer of 2014 pursuant to SB 617 for the submission of alternatives to the current LCFS regulation, and what was understood about the developing proposed amendment to the LCFS regulation, as well as the developing proposed ADF regulation.[38] The threshold question that the Board must therefore address is whether it considers itself bound by the Government Code to consider Growth Energy's proposed alternatives to what the CARB staff has now proposed. If the Board believes it has no such obligation, Growth Energy requests that CARB explain its reasons, and specify the deficiencies in Growth Energy's proposed alternatives.

LCFS 46-65

1. The Apparent Goals of the LCFS Program

Assuming that the Board agrees that it needs to consider Growth Energy's alternatives under the Government Code, the next task is to determine what benefits the CARB staff is claiming for its LCFS proposal. In that regard, the SB 617 process in 2014 was illuminating. Growth Energy's proposal would have required, depending on the CARB staff's view on the need to control upstream GHG emissions associated with the use of biofuels in California, an amendment to the current AB 32 cap-and-trade regulation applicable to the transportation fuels section.[39] The

LCFS 46-66

[38] *See* Appendix F.

[39] *Ibid.*

CARB staff responded as follows in the Consolidated Standardized Regulatory Impact Statement ("CSRIA") for the LCFS and ADF proceedings:

> ARB is required to analyze only those alternatives that are reasonable and that meet the goals of the program as required by statute. An initial assessment of the program indicates the goals of the LCFS proposal can be achieved by keeping the program '…separate of the AB 32 Cap-and-Trade system initially (at least first 10 years) in order to stimulate innovation and investment in low-GWI [global warming intensity] fuel (or transportation) technologies.' Due to the strong justifications that the Cap-and-Trade program alone generates neither the CI reductions nor fuel in the transportation sector, this alternative will not be assessed in this document.

CSRIA at 27 (footnote omitted.). Importantly, the CSRIA conceded that Growth Energy's proposed alternative would "likely" achieve the same "estimated GHG emissions reductions" as the current regulation in the period up to 2020. (*Id*. at 26-27.)

The deficiency in the Growth Energy proposal, according to the CSRIA, was not that it created a GHG emissions reduction shortfall at any point prior to the end of the current regulatory horizon; instead, the problem is that the Growth Energy proposal did not rely on the same purported strategy of fuels diversification and achievement of GHG emissions reductions as proposed by CARB. As Appendix A of the CSRIA explained:

> Transportation in California was powered almost completely by petroleum fuels in 2010. … Transitioning California to alternative, lower-carbon fuels requires a very focused and sustained regulatory program tailored to that goal. … In the absence of such a program, post-2020 emissions reductions would have to come from a transportation sector that would, in all likelihood, have emerged from the 2010-2020 decade relatively unchanged. ***In the absence of an LCFS designed to begin the process of transitioning the California transportation sector to lower-carbon fuels starting in 2010, post-2020 reductions would be difficult and costly to achieve.*** This is why the primary goals of the LCFS are to reduce the carbon intensity of California fuels, and to diversify the fuel pool. A transportation sector that achieves these goals by 2020 will be much better positioned to achieve significant GHG emissions reductions post-2020.

LCFS 46-66 cont.

CSRIA at 27 (emphasis added). In essence, the CSRIA claimed that fuels diversification and carbon intensity requirements were necessary in order to make post-2020 greenhouse gas reductions less costly and less difficult to achieve. The text of AB 32 does not itself require the use of a fuels diversification strategy or CI indexes to achieve GHG reductions, and certainly does not mandate the use of regulations intended to reduce the carbon intensity of transportation fuels to achieve greenhouse gas reduction, in order to achieve "the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions." Cal. Health & Safety Code § 38562(a). If the Board believes otherwise, Growth Energy requests that CARB identify the statutory text within AB 32 that requires the creation of a fuels diversification strategy or the use of CI regulations to reduce GHG emissions.[40]

LCFS 46-66 cont.

Assuming the CARB staff's position on the need for a LCFS program now (*i.e.*, from the present time until 2020) must be linked back to the purpose of AB 32 (which is to reduce GHG emissions), the staff's position seems to be that the regulation of the carbon intensity of transportation fuels is necessary now in order to reduce the costs or difficulties of achieving greenhouse gas reductions after 2020. Certainly, the CARB staff cannot defend its current proposal on the basis of any GHG reductions it will achieve: as noted in Part III.A.3 of these comments, the CARB staff has apparently abjured any effort to quantify the GHG reductions that the new LCFS regulation will achieve, either before or after 2020. In other words, the current LCFS program, stripped to its essential purposes, is not a measure to achieve any quantity of GHG

LCFS 46-67

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[40] The CSRIA identified a white paper published in 2008 by researchers at the University of California (Davis) as support for the CARB staff's position on the need for CI-based regulations. If CARB believes that the 2008 white paper bears on the scope of its authority or discretion under AB 32, it should explain why.

LCFS 46-66 cont.

emissions reductions over an identified time period; it is a measure to prepare California to achieve some unspecified quantity of GHG reductions at some time in the future.

LCFS 46-67 cont.

2. The Requirements of Section 11346.9(a)(4)

As also indicated in Part III.A.3 of these comments, absent some "quantifiable" GHG emissions reductions, a regulation adopted under color of AB 32 is not within the scope of CARB's authority; the proposed new LCFS regulation is therefore invalid under section 11342.2 of the Government Code. Even CARB were to take a different view of the scope of its authority under AB 32, the Board would still need, under the California APA, to prove that Growth Energy's alternative does not meet the criteria of section 11346.9(a)(4).[41] The CARB staff has given the Board no basis for claiming to have so proved. Several points are important on this issue.

LCFS 46-68

First, as Growth Energy pointed out in its SB 617 proposal last year, the federal renewable fuels program provides for the production and sale of cellulosic and "advanced" biofuels in the same time frame as the LCFS regulation. While the federal program does not require the use of electricity or hydrogen as a transportation fuel, the California motor vehicle emissions control and zero-emission vehicle programs (also noted in Growth Energy's proposal) certainly do.[42] The record in this rulemaking is devoid of any demonstration that the LCFS program will increase fuels diversification more than the federal RFS program and the State's electric-vehicle and related

LDFS 46-69

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[41] The text of the APA makes it clear that the agency has the burden of proving "with supporting information" that no alternative considered by the agency would meet the criteria of section 11346.9(a)(4). If the Board does not agree that it has that burden, it should explain why not. In addition, the Board should articulate the standard that it believes would apply to judicial review of the determination required in section 11346.9(a)(4), and explain its full basis for choosing that standard.

LCFS 46-68 cont.

[42] *See* Appendix F (Growth Energy's proposed alternative to the LCFS regulation, describing the programs that will achieve the fuels diversification sought by CARB, in the absence of the LCFS regulation).

LCFS 46-69 cont.

programs will. To the contrary, the CARB staff has admitted that it is "unclear to what degree" the LCFS program will require "new production" of "less carbon-intensive fuels … in California or elsewhere."[43] If the record currently contains an analysis that estimates the increase in fuels diversification that the LCFS regulation will achieve compared to the federal RFS program, CARB should identify.

LCFS 46-69 cont.

Second, as should be clear from the ADF ISOR and in the ADF ISOR's accompanying materials, the use of the CI-based regulatory strategy that the CARB staff is recommending will impose costs on the California motoring public, if they bear any costs of the mitigation strategy that the use of the LCFS regulation will require. As Growth Energy has demonstrated in Part III.B and the related Appendices, those costs may be even greater if CARB adheres to its duties under CEQA (though the cost-effectiveness of the mitigation strategy will not change). In addition, the increases in GHG emissions entailed in moving sugarcane ethanol to California (see Part III.A and Appendix G) will likely need to be offset by other types of GHG controls, which will impose additional costs on California consumers and businesses. The CARB staff has not offered any analysis to the Board that explains why those ***present*** costs, along with the direct costs of the LCFS program in the near term, are worth incurring in order to make the ***future*** costs of post-2020 GHG emissions reductions less costly. Conclusory or self-serving statements by businesses who claim that they will construct facilities or produce and market advanced, diversified liquid biofuels are entitled to no weight.

LCFS 46-70

[43] *See* LFCS ISOR Appendix E at E-5.

Third, the long-run, post-2020 plans for GHG reductions developed by CARB call for the phase-out of reliance on liquid biofuels;[44] low-CI liquid fuels, however, are presumably the fuels whose production is in need of diversification, according to the CSRIA. Eventually, the State plans to eliminate gasoline, in particular, from use in California cars and trucks and to fully replace gasoline with electricity. Putting to the side whether CARB's post-2020 strategy is meritorious, the CARB staff has given the Board no basis to explain why CARB should impose costs on California consumers and businesses to foster the use of fuels that (according to CARB) are destined for a diminishing, and no long-term, role in its greenhouse gas reduction strategy.

LCFS 46-71

One other important, procedural point must also be noted here. The demonstration required by section 11346.9(a)(4) that there are no superior alternatives to a proposed regulation (as the statute defines superiority) must be based on "supporting information." At present, there is no such "supporting information" in the rulemaking file of which Growth Energy is aware, perhaps because the CARB staff has looked ahead to the Board's obligations under section 11346.9(a)(4) of the Government Code. If the Board intends to add such information to the rulemaking file in order to try to carry its burden under section 11346.9(a)(4), it must comply with section 11347.1 of the Government Code.

LCFS 46-72

In sum, with regard to the LCFS proposal, CARB is not currently positioned to proceed with final rulemaking because, among other reasons, it cannot discharge its obligations under section 11346.9(a)(4) of the Government Code. If the Board intends to pursue the staff's proposal, it must address the issues raised here, both substantive and procedural.[45]

LCFS 46-73

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[44] *See* http://www.arb.ca.gov/planning/vision/vision.htm.

[45] If the Board does not agree with Growth Energy's analysis of the obligations of section 11346.9(a)(4), Growth Energy requests that the Board explain its reasons for disagreement.

B. Requirements of Transparency

Section 11347.3 of the Government Code requires CARB to maintain a "file of [the] rulemaking proceeding" for any proposed regulatory action subject to the APA, including the LCFS regulation." The rulemaking file must include, among other items, the following:

> (6) All *data and other factual information,* any studies or reports, and written comments submitted to the agency in connection with the adoption, amendment, or repeal of the regulation.
>
> (7) All data and other factual information, *technical*, *theoretical*, and *empirical studies or reports*, if any, on which the *agency is relying* in the adoption, amendment, or repeal of a regulation, including any cost impact estimates as required by Section 11346.3.

Gov't Code § 11347.3(b)(5),(6) (emphasis added). The entire rulemaking file, including the foregoing material, must be "available to the public for inspection" from the time when the first notice of the proposed rulemaking is published in the California Regulatory Notice Register, *id.* at § 11347.3(a), which here occurred on January 2, 2015.

As the above-quoted text makes clear, rulemakings at CARB must include the creation of a rulemaking file that includes "***[a]ll*** data and other factual information, any studies or reports, and written comments submitted to the agency" in connection with the proposal. Gov't Code § 11347.3(a),(b)(6) (emphasis added). To assure immediate public access to the supporting materials as soon as the 45-day materials are released, the APA requires that the 45-day notice include a statement that the agency on the date of the notice "has available *all* information upon which [the] proposal is based." *Id*. § 11346.5(a)(16) (emphasis added). A separate provision confirms that the agency must in fact make those records, and any other "public records, including reports, documentation, and other materials, related to the proposed action," available. *Id.* § 11346.5(b).

The "written comments" that must be placed in the record are not simply those submitted to the agency in a particular manner or at a particular time, such as during the period between publication of the notice of a public hearing and public hearing -- an agency must put "all" it receives "in connection with" a regulatory proposal in the rulemaking file. The Legislature's choice of words to describe what comments must be placed in the file -- "in connection with" -- sweep with intentional breadth, and require inclusion of any comments that bear on the subject of the regulatory effort. In addition, the period of public availability must "[c]ommenc[e] *no later than* the date that the notice of the proposed action is published." *Id.* § 11347.3(a) (emphasis added). The use of the term "no later than" makes it clear that the Legislature expected written comments submitted in connection with a proposed regulatory action and received before publication of the required notice to be included in the rulemaking file.

LCFS 46-74

Growth Energy has substantial concerns about the completeness of the rulemaking files for the current LCFS and ADF rulemakings, as it did in the prior LCFS rulemaking in 2009. The Court of Appeal made clear in *POET v. CARB* that neglect to include even a limited number of relevant documents in the rulemaking file would violate the Government Code. To avoid further controversy, Growth Energy requests that the Executive Officer or the CARB legal staff consider and respond to the following questions:

LCFS 46-75
ADF 17-11

1. Does the CARB legal staff agree that the rulemaking file for these two proceedings must include external communications submitted to the staff, the Executive Officer or the Board prior to the date when the rulemaking file is formally opened must be included in the rulemaking file, if those communications were submitted in connection with the adoption or amendment of ADF and/or LCFS regulation? Conversely, does the CARB legal staff believe that no such external communications submitted before the rulemaking file would come within the definition of records

LCFS 46-76

required for inclusion in the file, pursuant to section 11347.3(b)(6)? Are there any written guidelines or instructions used by the CARB staff to determine whether a communication submitted before the file is opened must be included in the file? Are there any written guidelines or instructions that the CARB staff uses in order to determine what constitutes "data … other factual information … studies or reports," or "written comments," that should be included in the rulemaking file? Will any such guidelines or procedures be made available?

LCFS 46-76 cont.

2. The ADF rulemaking was opened in 2013 and then pretermitted in 2014. What steps have been taken to assure that that all external submittals (not within the scope of section 11347.3(b)(7) concerning the 2013-2014 regulatory process were included in the ADF rulemaking file opened in January 2015? If the CARB legal staff believes that no such external submittals before January 2015 were required to be included in the "new" rulemaking file, was there any process by which the public could obtain prompt access to those materials?

ADF 17-12

Turning to the requirements of section 39601.5 of the Health & Safety Code, as noted in Part I, the Legislature in AB 1085 directed CARB to provide "all information" on key aspects of its regulatory analysis "before the public comment period for any regulation" commences under the Government Code. Growth Energy requests that the CARB legal staff explain what steps were taken to provide all the information covered by section 39601.5 in connection with the current LCFS and ADF rulemakings. Growth Energy requests that each document or other file made available to the public under section 39601.5 prior to January 2, 2015, in connection with these two rulemakings be identified, along with the date it was made available and the method by which it was made available.

LCFS 46-77

C. The SB 617 Process

As the correspondence included in Appendix F makes clear, the version of the ADF proposal on which the CARB staff invited comment and responses in the SB 617 process in 2014

ADF 17-13

differed materially from the version of the ADF proposal that the CARB staff was discussing with some stakeholders, and that the CARB staff eventually included in the current rulemaking package. Those differences related to the circumstances under which mitigation would be required, and thus both to the environmental impacts and the costs of ADF regulation. Growth Energy believes that CARB did not substantially comply with SB 617 in connection with the ADF rulemaking, and that the Department of Finance failed to perform a mandatory duty to notify CARB and the public of CARB's noncompliance and to require CARB to comply. Growth Energy therefore requests that the Board reopen the SB 617 process, and allow that process to proceed simultaneously with other work on the ADF regulation. If the Board believes there was substantial compliance with SB 617 in the ADF rulemaking process, Growth Energy requests that CARB explain the basis for that belief.

ADF 17-13 cont.

D. External Peer Review

The Executive Officer has indicated that he has sought external scientific peer review in connection with the LCFS rulemaking. The subjects of that peer review effort, however, are unknown, and it is not clear whether the Executive Officer has sought peer review under section 57004 of the Health & Safety Code for the scientific basis and scientific portions of any part of the currently proposed ADF regulation. If no such peer review has been sought and completed, Growth Energy requests an explanation of the reason why none was sought and completed.

ADF 17-14

V. CONCLUSION

Growth Energy appreciates the opportunity to participate in these rulemakings. Growth Energy believes that the current record does not enable the Board to adopt the regulatory proposals presented by the staff, and hopes that the Board will reconsider the staff's decision not to propose the alternative to the LCFS program that Growth Energy offered in the SB 617 process in 2014. If adopted, the current LCFS proposal will have a devastating impact on Growth Energy's

members, who will be forced to exit from the California alternative fuels market. Such an outcome will likely trigger the cost-containment caps in the proposed regulation, and any claimed benefits of the LCFS program will be compromised or lost. By contrast, Growth Energy's alternative proposal will assure the continued supply of reasonably-priced renewable fuel to the California market, and can achieve the same overall GHG reductions as sought by the 2009 LCFS regulation while not creating any increases in criteria pollutants.

Respectfully submitted,

GROWTH ENERGY

February 17, 2015

17_OP_ADF_GE Response (Page 1 – 54)

92. Comment: **ADF 17-2 through ADF 17-10**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

93. Comment: **LCFS 46-1 through LCFS 46-5, LCFS 46-10, LCFS 29 through LCFS 46-35. LCFS 46-41, and LCFS 46-44 through LCFS 46-69.**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

94. Comment: **LCFS 46-6 through LCFS 46-9, LCFS 46-11 through LCFS 46-28, LCFS 46-36 through LCFS 46-40, LCFS 46-42, LCFS 46-43, LCFS 46-70, LCFS 46-72 through LCFS 46-74, LCFS 46-76, and LCFS 46-77.**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

95. Comment: **ADF 17-1**
The comment states that ARB failed to comply with SB 617 requirements because staff was revising its ADF regulation by the time ARB submitted the Standardized Regulatory Impact Analysis (SRIA) to the Department of Finance (DOF).

Agency Response:
ARB fully complied with SB 617. SB 617 does not prohibit an agency from continuing to work on a proposed regulation and consulting stakeholders after the economic analysis commences for the SRIA. Neither does it require an agency to submit a revised SRIA to reflect changes made in the proposal after the time the original economic analysis begins, or after submittal of the SRIA to DOF. Preexisting APA requirements such as required economic analysis in the Form 399 were left intact when the Legislature enacted SB 617. Thus, the analysis of a proposed regulation's economic impacts can be updated, as needed, in the Initial Statement of Reasons (which launches the formal rulemaking process) and in the

Standardized Form 399 Economic and Fiscal Impact Statement (Form 399), which contains the agency's findings regarding the economic and fiscal impacts of the regulation in its final form.

Over a period of several years, ARB held 22 LCFS public workshops and 24 ADF public workgroup or workshop meetings as part of developing these two related regulations. All of this work informed evolving proposals that the public processes are intended to improve. At no point prior to the Board's final adoption of a regulation is any proposal carved in stone. While the economic analysis was underway for the SRIA, and after submittal of the SRIA to DOF, ARB continued to solicit and incorporate feedback and continued to review available information and regulatory options, and this ongoing work was disclosed in the SRIA itself. ARB expressly noted that "the final…regulation…to be proposed to the Air Resources Board for consideration of adoption in 2015, will be informed by continued interactions with stakeholders, external researchers, and other regulatory agencies." In reply, DOF's comments on the SRIA noted that "[the Department of] Finance understands that the proposed regulations may change… If any significant changes to the proposed regulations result in economic impacts not discussed in the SRIA, please note that the revised economic impacts must be reflected on the Standard Form 399…" Finally, DOF's comments to ARB did not indicate that there were any missing components required by SB 617 or that ARB's continuing work on the proposed regulations deprived DOF of the ability to provide meaningful comment and direction on ARB's economic impact analysis.

For the ADF and LCFS proposals to be approved, in fact, DOF will have to review and approve the final Form 399 prepared by ARB; this form will include an updated economic impact analysis based on the final proposed regulations, including all modifications made to the proposals since the time the SRIA analysis commenced. Similarly, stakeholders and members of the public had the opportunity to comment on not just the SRIA, but the updated economic analysis included in the Initial Statements of Reasons for the ADF and LCFS proposals. The updated analysis not only considered changes made in the ADF and LCFS proposals up to the time of ARB's Notice of Proposed Rulemaking, but also included DOF's comments on the SRIA and ARB's responses to those comments. In fact, changes to the two regulatory proposals between the time the initial economic analysis began and the time of the Notice of Proposed Rulemaking did not result in substantial changes to the modeled economic impacts of the two proposals.

96. Comment: **ADF 17-11/LCFS 46-75**
The commenter expresses its concern about the completeness of the rulemaking files in the ADF and LCFS rulemakings.

Agency Response:
ARB staff believes the rulemaking file is complete. Please see response **ADF 5-3.**

The commenter goes on to propound a series of *questions*, requesting responses from "CARB legal staff." Such questions do not constitute "an objection or recommendation made regarding the specific adoption . . . proposed" within the meaning of Government Code section 11346.9(a)(3).

The commenter also requests that CARB perform detailed clerical and paralegal tasks. For example, the commenter requests that "CARB legal staff" explain various matters and identify:

[1] "each document or other file made available to the public under section 39601.5 prior to January 2, 2015, in connection with these two rulemakings;"

[2] provide "the date it was made available;" and

[3] provide "the method by which it was made available."

Again, ARB notes these requests are not "objections or recommendations" under Government Code section 11346.9(a)(3). ARB is not obligated to undertake these requests as part of its response to public objections or recommendations regarding the proposal, and declines to ask its legal staff to do so.

97. Comment: **ADF 17-12**
The comment requests the steps ARB took to ensure all comments submitted during the 2013 rulemaking process were included in the 2015 rulemaking.

Agency Response:
All comments that were submitted as part of the 2013 ADF rulemaking 45-day comment period were included in this rulemaking's 45-day comment period, and responses to those comments are included here. ARB was not required to consider comments submitted on the 2013 proposal as part of this rulemaking, but agreed to do so for the convenience of those who took the time to comment on the 2013 proposal. Please see response **ADF 17-11**, regarding the rulemaking file completeness. This response also includes a reference to **ADF 5-3**.

98. Comment: **ADF 17-13**
The comment states that because the ADF proposal changed after ARB's solicitation of alternatives from the public at the outset of the economic analysis that was presented in the SRIA, ARB did not comply with SB 617. The comment is essentially the same as **ADF 17-1**.

Agency Response:
Please see response **ADF 17-1**, for more detailed information.

At the time ARB solicited alternative proposals pursuant to SB 617, ARB shared its then-current thinking on the form of a possible proposal which had yet to be formally presented to the Board or the Office of Administrative Law – and under the terms of SB 617 could not yet be formally proposed. That solicitation fulfilled the purpose of SB 617, and the input from that solicitation as well as information gathered through other pre-rulemaking processes continued to shape the proposal.

99. Comment: **ADF 17-14**
The comment requests clarification of whether a peer review was sought and, if not, an explanation of the reason why a peer review was not sought or completed.

Agency Response:
In November 2013, ARB requested peer review of the Multimedia Working Group's (MMWG's) assessment of the biodiesel and renewable diesel multimedia evaluations and the proposed ADF regulation. The peer review was completed in February 2014.

Under Health and Safety Code (HSC) section 43830.8(d), an external scientific peer review of the multimedia evaluation must be conducted pursuant to HSC section 57004. The purpose of the peer review is to determine whether the scientific portions of the MMWG Staff Report are based upon "sound scientific knowledge, methods, and practices" (HSC 57004(d)(2)).

After the peer review was completed, new information became available, including a biodiesel exhaust emissions study and various public health studies. Additionally, peer reviewers also provided additional scientific sources as part of their critical review. The MMWG reviewed these studies, conducted further review of new available information, and updated the Staff Report accordingly. Modifications include updates to the air quality and public health evaluations based on a new biodiesel study and other scientific publications, and revisions to the Staff Report based on the information and comments from the initial peer review.

In January 2015, ARB staff requested a supplemental peer review of the revised biodiesel Staff Report and updated ADF regulation. Given the extensive nature of the initial review, the MMWG was pleased to have four of the original reviewers participate in the supplemental review. The reviewers reviewed the updated portions of the report, as well as the MMWG's response to previous comments and corresponding revisions to the report.

Overall, the reviewers determined that the MMWG's conclusions were based on sound scientific knowledge, methods, and practices. The MMWG made final revisions to the Staff Report and addressed each comment in a written response.

The final biodiesel and renewable diesel Staff Reports, including the peer reviewers' written reviews and the MMWG's response to peer review comments, are posted on the Alternative Diesel Fuel webpage at: http://www.arb.ca.gov/fuels/diesel/altdiesel/biodiesel.htm.

Appendix A

Comments on ARB's Corn Ethanol Land Use Emissions

February 10, 2015

Air Improvement Resource, Inc.

Introduction

ARB presented a new land use emission estimate for corn ethanol in the Initial Statement of Reasons (ISOR). The derivation of this estimate was discussed in Appendix I to the ISOR. ARB developed the corn ethanol estimate from the average of 30 scenarios, where each scenario represented a unique run of the Global Trade and Analysis Project (GTAP) model. The 30-scenario average is 19.8 g CO2 e/MJ. This value is 10.2 gCO2/MJ lower than ARB's current estimate of 30 g CO2e/MJ.

ARB held 3 workshops in developing the new LUC values; one in March 2014, one in September 2014, and a final one in November 2014. AIR participated in all 3 workshops, and submitted comments to the Staff on all 3 workshops. Our previous comments are included as Attachments 1-3 to this document.

Very little changed in ARB's emissions for corn between the November 22 workshop and the ISOR. The value at the November 22 workshop was 20.0 g CO2e/MJ.

Through the workshop process, we have made a number of comments on the Staff's approach and analysis. One comment was adopted, but the remainder were either ignored or shifted to ARB's "Long Term" project list. Table 1 below summarizes the status of comments made. We have divided the recommendations into two categories – GTAP, and AEZ-EF. [1] We have included 3 categories for the status – adopted, ignored, or shifted to long-term.

[1] GTAP determines how much and what type land is needed and where, and the AEZ-EF model determines the emissions of the various land transitions. Both models are needed to estimate LUC for a biofuel.

Table 1. Status of Recommended Items					
Category	AIR Recommendation	Adopted	Ignored	Long-Term	
GTAP	Revise the model land supply structure	X			
	Drop the lower price-yield values		X	X	LCFS 46-79
	Include multiple cropping effects			X	LCFS 46-80
	Evaluate land intensification effects		X	X	
	Include effects of conservation reserve program (CRP)			X	LCFS 46-81
	Include additional effects of fertilizer, livestock, paddy rice emissions			X	LCFS 46-82
	Develop and include cropland-pasture from other regions			X	LCFS 46-84
AEZ-EF	Do a comparison of CCLUB to AEZ-EF		X	X	LCFS 46-85

Table 1 shows that many of the items recommended have simply been shifted for future study. Most of these items were raised by both AIR and the Expert Working Group (EWG) at least 4 years ago (two examples are (1) including CRP in the analysis, and (2) including the effects of livestock and rice paddy emissions). We have listed several items as either being ignored and shifted to the future or just being ignored, because either Staff's response to our input was inadequate, or it was not addressed at all in the ISOR, or both.

For many of the items that have been shifted to further study, we have presented in comments submitted previously, information showing they could be included now (examples are land intensification effects). Some items shifted to further study legitimately require further study, for example, including cropland-pasture from other regions.

Overall, we believe the LUC value of 19.8 gCO2e/MJ for corn ethanol is still too high. The implications of overestimating the LUC value for corn ethanol are that it could lead to shuffling of fuels without any reduction in greenhouse gases and increased costs of compliance with the LCFS. LCFS 46-78

The following section discusses each of the comments above. We skip a discussion of the model structure, since that comment was adopted by the staff.

Price-Yield Values

The ARB analysis uses five price-yield values: 0.05, 0.10, 0.175, 0.25, and 0.35. The average of these 5 values is 0.19. The Purdue recommended value is 0.25, and the EWG recommended 0.25. ARB sponsored research indicating that there was little or no price-yield response (i.e., 0.0). Our comments on price yield were that ARB should drop the lower price yield values (0.05 and 0.10) because the research supporting these lower values was developed over the very short term (1-3 years of price and yield data), and the GTAP model is a longer-term model (5-10 years). [2] ARB utilizes an 11.59 billion gallon per year shock of corn ethanol in its corn ethanol modeling, clearly illustrating that ARB is exercising the model with a medium-term shock, and not a short term shock. Thus, ARB's use of short term price yield responses with the medium or longer term GTAP model is clearly inconsistent.

In the ISOR, ARB references a recent analysis by David Rocke at UC Davis in support of using lower price-yield responses. [3] The Rocke analysis utilized one set of data from a 2012 dissertation by Juan Francisco Rosas Perez. [4] The dissertation indicated that the price-yield response was in the region of 0.29, very close to the Purdue default value. Rocke obtained the data from the dissertation, conducted his own statistical analysis, and concluded that the data did not support the 0.29 price yield value.

Because of the differences between these two analyses (Perez and Rocke), which are clearly important to understand fully, AIR requested the data Rocke used for his analysis from ARB staff. While staff said they were trying to get the data for AIR, the data was never supplied by staff. Therefore, we were unable to replicate Rocke's analysis of the Perez data. There is not enough information in Rocke's write-up to reject the Perez analysis (the rebuttal is only 3 pages). In addition, this is only one of two sources (according to Rocke) that were used to support the 0.25 price-yield value, Rocke did not attempt to critique the other source. Thus, because we were not able to replicate Rocke's sketchy analysis, and Rocke only critiqued one source, ARB cannot rely on the Rocke analysis for its use of low price-yield values, and should therefore eliminate the lowest value (0.05), or the lowest two values (0.05 and 0.10).

The impacts of eliminating one or both of these values on corn ethanol LUC emissions is shown in Table 1. Without the lowest price yield value of 0.05, the LUC value for corn is 17.62. Without both 0.05 and 0.10, the LUC value is 15.53

LCFS 46-79 cont.

[2] "Discussion of the Yield Price Elasticity of GTAP", Taheripour and Tyner, Purdue University, April 2014.

[3] "Statistical issues Related to the Low-Carbon Fuel Standard", October 31, 2014.

[4] "Essays on the Environmental Effects of Agricultural Production", Dissertation, Perez, Juan Francisco Rosas, Iowa State University.

gCO2e/MJ. As before, we recommend that ARB eliminate the lowest two price-yield values.

LCFS 46-79 cont.

Table 1. Impact of the Low Price-Yield Values		
Average of ARB Scenarios	Average price-yield	LUC (gCO2e/MJ)
All (ARB value)	0.19	19.84
w/o 0.05 price-yield	0.21	17.62
w/o 0.05, 0.1 price-yield	0.26	15.53

Multiple-Cropping and Land Intensification

GTAP currently does not include any double or multiple cropping. When crop prices increase, producers get more out of the same piece of land by planting second and even third crops. This is particularly true in Brazil, where corn is planted on soybeans, and even in the US, where wheat is planted and corn/soybeans are planted in the same year. This is one process of land "intensification", whereby existing cropland is used to a greater degree before conversion of non-cropland.

In our September 2014 workshop comments (Attachment 2) we pointed out that multiple cropping can be conservatively modeled by increasing the price yield value. We recommended a +0.05 increase in price yield from about the 0.25 Purdue default level to 0.30, other commenters have recommended similar and higher amounts. Ignoring multiple cropping, as ARB is currently doing (or, just deferring including it to some unknown future date) is not technically acceptable or defensible.

The empirical evidence for intensification globally was developed from data by the Babcock/Iqbal analysis, which we covered in detail in our comments on the November 22 workshop. [5] This analysis showed that over the last 10-15 years of biofuel expansion, there has been no net land conversion from forest and pasture to crops in many regions such as the US, Western Europe, and China. In our November comments (Attachment 3), we developed a filter that could be applied to the ARB results based on GTAP to estimate LUC of biofuels. We showed that application of this filter would reduce LUC from corn ethanol from 20 gCO2/MJ to a range of 6-13 g CO2e/MJ (see Table 2 in Attachment 3).

ARB has known about the inability of GTAP to account for multiple cropping since the last time land use values were adopted in 2009. It is inexcusable that ARB would still be relying on LUC values that do not include multiple cropping or more generally, some accounting for land intensification. We have provided two methods to ARB for accounting for these effects in this version of LUC estimates – either use a somewhat high price-yield factor, or use the filter we developed from the

LCFS 46-80 cont.

[5] Using Recent Land Use Changes to Validate Land use Change Models", Babcock and Iqbal, Staff Report 14-SR- 109, Center for Agriculture and Rural Development, Iowa State University, www.card.iastate.edu.

Babcock/Iqbal study. These methods can be applied conservatively to avoid over-accounting for their effects. Of course, this, as well as many other issues, could also be studied further in the future. But some accounting for multiple cropping and land intensification should be included with this LCFS re-adoption.

LCFS 46-80 cont.

Conservation Reserve Program

Our comments have also consistently pointed out that ARB should also include the effects of Conservation Reserve Program land (CRP) in mitigating land use emissions. The GTAP model already includes the computer code to access CRP land.[6] We have also presented direct evidence from USDA statistics that conversion of CRP back to crop has already occurred over the last five years (see Table 2 of our comments on the March 11 workshop, Attachment 1). Therefore, we are not discussing a theoretical possibility of this conversion occurring in the future with biofuel expansion. It has already happened, and ARB has ignored it.

Inclusion of US CRP land in estimating LUC of biofuels would clearly lower LUC values. The carbon stored on CRP (above and below ground) reactivated to crops would be similar to ARB's current estimate for pasture. It could even be a little higher than pasture, if shrubs and other plants had started to grow on this land. In some cases, CRP land could even include some young forest. However, it is not likely that forest CRP land would be reactivated back to crops, rather the CRP converted back to crops would be land relatively easy to convert. But the inclusion of CRP land in GTAP modeling would reduce overall the forest estimated to be converted in the US, thereby showing a reduction in GHG emissions from the case of not including CRP land in the analysis.

LCFS 46-81 cont.

Include Livestock and Paddy Rice Emission Credits

These are other indirect effects that were identified at the time the last land use values were finalized by the ARB. The biofuel shocks increase crop prices, thereby reducing livestock herds and also reducing the paddy rice crop. Livestock and rice produce prodigious amounts of methane, so the reduction in these two items reduces GHG emissions from biofuels. EPA included these effects in its implementation of the Renewable Fuel Standard in 2010. Given that EPA included these effects several years ago, it is surprising that ARB postponed the inclusion of these effects in their modeling.

LCFS 46-82 cont.

Include Fallow Land

[6] The AEZ-EF appendix indicates that "GTAP-BIO does not consider conversion of CRP land." This is not exactly true. The computer code for including this land is in the model, and it is easy to activate. AIR has activated this code, and GTAP, along with AEZ-EF (assuming CRP land is similar to pasture) predicts a 1-2 gCO2/MJ reduction for including CRP land in the analysis.

We showed in Table 6 of our comments on the November workshop (Attachment 3) that worldwide there are 193 million hectares of fallow land. The model currently has no capability of accessing this land for increased crop production even though it is probably the most likely land to respond to higher crop demand and is land that could be brought into production without any land use change.

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Include Cropland-Pasture from other Regions

The GTAP model includes cropland-pasture for the US and Brazil. Cropland-pasture is land that is used alternatively for either cropland or pasture, depending on economics to the producer and other factors. The inclusion of the land type for these two countries reduced LUC emission predictions from GTAP significantly. The US and Brazil are not the only regions with cropland-pasture. Canada, Western Europe, and some other regions also utilize cropland-pasture.

LCFS 46-84 cont.

Compare CCLUB to AEZ-EF

ARB uses its AEZ-EF model to estimate the emissions of various land transitions, for example, forest to crop, pasture to crop, crop to pasture and so on. The model was not finalized and released until late November 2014.

AIR has previously commented that ARB should also evaluate LUC emissions with the CCLUB model. [7]CCLUB is used by Argonne to estimate LUC emissions for various biofuels in the GREET model (GREET2013, GREET2014). CCLUB was available in late 2013. CCLUB basically uses the same international emissions that EPA used in the RFS, but has much more detailed emissions for the US. CCLUB is not even referenced by the AEZ-EF documentation. ARB claims to have evaluated CCLUB, but there is no indication of that in either the AEZ-EF documentation, in Appendix I, or in the ISOR. [8] Therefore, due to the fact that ARB released the final AEZ-EF model so late in the process, and that there are no references to CCLUB in any of the ARB documentation, we are not clear on what the advantages there are to AEZ-EF over CCLUB. There was little time for us to perform an in-depth analysis of the differences in these two models that estimate the emissions of various land transitions.

AIR evaluated the impact of using CCLUB instead of AEZ-EF for predicting emissions. The impacts are shown in Table 2. LUC emissions with CCLUB are less than ½ of ARB's AEZ-EF model. AEZ-EF is not superior to CCLUB, certainly the most technically defensible parts of both models should be combined.

LCFS 46-85 cont.

[7] Dunn, J., Mueller, S, Kwon, H.Y., Wander, M., Wang, M., "Carbon Calculator for Land Use Change from Biofuels Production (CCLUB)", Argonne National Laboratory, ANL/ESD/13-8, September 2013.

[8] In their list of long-term updates to LUC in the ISOR, ARB's number 2 item is to "use improved emission factors, as they become available." However, it appears ARB has not fully evaluated emission factors in CCLUB, which were available long before ARB finalized its AEZ-EF model.

Table 2. Comparison of Corn Ethanol LUC Emissions	
Scenario	LUC (g CO2e/MJ)
ARB Average Inputs with AEZ-EF Emissions	17.14
ARB Average Inputs with CCLUB Emissions	7.77

LCFS 46-85 cont.

Attachment 1

Comments on ARB's March 11 Workshop on
The Low Carbon Fuel Standard
Air Improvement Resource, Inc.
April 6, 2013

These comments are primarily on the workshop presentations provided by CARB, and some of the documentation provided by CARB on the AEZ-EF model shortly after the workshop. The following comments focus on Land Use Change and Facility Registration components of the LCFS.

Land use Change Emissions

There are two models used to estimate the land use change emissions – the Agri-Economic Zone Emission Factor (AEZ-EF) model, and the Global Trade Analysis Project (GTAP). GTAP is a general equilibrium model used to determine land transitions (like pasture to cropland and forest to cropland) in similar agro-economic zones in various regions of the world. The AEZ-EF model is used in conjunction with the GTAP to determine emissions released by the land-use transitions.

We discuss the GTAP model first, followed by the AEZ-EF Model. We then use the ARB-GTAP model and a much more appropriate Purdue GTAP model to estimate the impacts of our recommendations of changes on land use change (LUC) emissions for corn ethanol.

Global Trade Analysis Project (GTAP)

GTAP contains global land pools of cropland, forest, pasture, Conservation Resource Program (CRP) land (in the US), and cropland pasture (in the US and Brazil). The base year for the current model is calendar year 2004. In modeling biofuel increases, the model is "shocked" with the biofuel increase (corn ethanol, for example), and since this requires a significant increase in corn production, the model converts some other cropland to corn production, converts some pasture to crop production, and converts some forest to crop production. The model also contains a price-yield elasticity, such that when the model is shocked for increased corn ethanol, crop prices increase, and yields also increase somewhat on all cropland. Thus, increased production is met through (1) cropland expansion into non-cropland (which creates land use change emissions), and (2) yield increases on existing cropland.

There are other ways in which crop production increases in addition to land expansion and yield increases. A 2013 study by Roy and Foley shows there are three other ways crop production increases: (1) using the existing standing cropland area more frequently by multiple cropping, (2) leaving less land fallow, and (3) having

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fewer crop failures.[9] None of these 3 ways involves a land use change, or land use change emissions. Furthermore, GTAP does not include these 3 factors: GTAP does not account for double cropping, has no fallow land inventory, and cannot model reduced crop failures. Roy and Foley point out that the influence in these 3 factors on crop production can be estimated by comparing trends in total harvested area to total cropland.

> The growth in annually harvested cropland and standing cropland has been changing in recent decades. Analyzing the 177 crops traced by FAO since 1961 shows that the amount of annually harvested land has increased much faster than the reported total standing cropland on the globe. While standing cropland has increased at the rate of 3.5 mha/year, the annually harvested land increased at a much faster rate of 5.5 mha/yr.

The difference in the above growth rates – 2.0 mha/year – is due to the 3 factors mentioned earlier, which have no land use emissions impact. The authors also examine the potential for the increase in harvested area to continue to increase faster than standing cropland in the future, and find that these trends should continue.

It is difficult to incorporate these factors into the current GTAP model, because these factors require a dynamic GTAP model, and the current model is a static model.[10] However, the analysis of these trends can be used to inform the ranges of input elasticities for the current static GTAP model used by ARB, particularly the price-yield elasticity. Increasing the price yield elasticity in GTAP increases crop production without a land use impact. Thus, the Ray/Foley study argues for a relatively high price-yield elasticity range. ARB, however, has selected a very low price yield elasticity range. This is discussed in more detail in the next section.

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Review of CARB's GTAP Modeling

Price-Yield Elasticity Range

GTAP includes a price-yield elasticity of 0.25 as a default. This level is in part based on extensive research by the GTAP modeling community. [11] The Expert Working Group also recommended this value. The EWG also recommended higher values for regions with significant double cropping, since GTAP does not explicitly include double cropping. GTAP researchers have also pointed out GTAP is a medium-term model, with projections being applicable in the 5-10 year timeframe. CARB appears to concur with this timeframe for GTAP, because CARB describes the model as a

[9] Ray, D.K., and Foley, J.A., *Increasing global harvest frequency: recent trends and future directions,* Environmental Research Letters, (2013), 044041, IOP Publishing.

[10] Purdue is continuing to develop a dynamic GTAP model for these and other reasons.

[11] Keeney and Hertel, "Yield Response to Prices: Implications for Policy Modeling", Working Paper #08-13, August 2008, Department of Agricultural Economics, Purdue University.

"Current" model, meaning, that its estimates are applicable to the 2013/2014 timeframe, even though its primary data is for 2004.[12]

CARB, however, performed sensitivity analyses using price-yield elasticity values from 0.05-0.30 (20%-120% of the default value). CARB's selection of the lower end of the range came from a variety of price-yield studies that were very short term (1-2 years) in nature, and were clearly not appropriate for the GTAP timeframe. All studies on data less than about 4 years should not even be considered in establishing the range of this parameter to use in modeling. Furthermore, CARB did not consider the analysis by Ray and Foley in determining the range of price-yield values to use.

CARB performed sensitivity analyses on several other parameters. Most of these values were in the range of 80%-120% of the GTAP default level, for example, CARB performed sensitivity modeling of the ETA parameter at the baseline (default), 80% of the baseline, and 120% of the baseline. We support performing sensitivity modeling at different price-yield levels, however, the range should be at least 80%-120% of the Purdue baseline value of 0.25, or 0.20 to 0.30. However even this range is not nearly high enough to properly reflect the increase in crop production that has occurred without land use changes reflected by Ray and Foley analysis referenced earlier.

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ETL1 and ETL2 Values

CARB updated the land transformation elasticities (ETL1 and ETL2) in GTAP prior to estimating land use changes. ETL1 governs the transformations between forest, crops, and pasture, and ETL2 governs the transformations between various crops. CARB appears to have used some, but not all, ETL1 and ETL2 values from a 2013 Applied Science paper by Taheripour and Tyner. [13] In the Applied Sciences paper, Taheripour and Tyner indicate

> We tune the regional land transformation elasticities based on actual historical observations on changes in land cover and distribution of cropland among alternative crops during the past two decades. To accomplish this task we use published data on cropland use around the world by the Food and Agriculture Organization (FAO) of the United Nations over the period 1990-2010.

The differences in ETL1 and ETL2 values between the Applied Sciences paper and CARB are shown in Table 1 below.

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[12] See page 57 of the CARB March 11 Workshop Briefing, iluc_presentation_handouts_031014.pdf.

[13] Taheripour and Tyner, "Biofuels and Land Use Change: Applying Recent Evidence to Model Estimates", Applied Sciences, 2013, 3, 14-38.

Table 1. Differences in ETL1 and ETL2 Values Between CARB and Purdue				
Region	Purdue – Applied Sciences 2013		CARB	
	ETL1	ETL2	ETL1	ETL2
Brazil	-0.30	-0.50	-0.20	-0.75
S_O_Amer	-0.30	-0.25	-0.10	-0.50
R_S_Asia	-0.10	-0.25	-0.10	-0.75
Russia	-0.20	-0.75	-0.02	-0.75
S_S_Afr	-0.30	-0.50	-0.30	-0.25

LCFS 46-87 cont.

It is not clear why CARB chose different ETL1 and ETL2 values than Purdue, and what analysis or data CARB based these values on. An explanation of this should be provided for review, or CARB should use the ETL1 and ETL2 values that were developed by Taheripour and Tyner.

Model Nesting Structure

The Applied Science paper referenced above also included another major improvement in GTAP. According to the paper

> The GTAP-BIO model puts three types of land cover items (forest, pasture, and cropland) into one nest an implicitly assumes that the economic costs of converting one hectare of forest to cropland is similar to the economic cost of converting one hectare of pasture land to cropland and vice versa. This set up another key deficiency of the GTAP-BIO model. Including cropland, forest, and pastureland in the same nest could cause systematic bias in land conversion processes among land cover types due to biofuel production. In general this is not the case and often the opportunity costs of converting forest to cropland is higher than the economic cost of converting pastureland to cropland.

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The Expert Working group studying elasticity parameters in GTAP identified this nesting structure as a key deficiency in the model and recommended using a revised nesting structure.

Taheripour and Tyner altered the land cover component of the land supply tree to have forest and pasture land in two different nests. Then they re-evaluated global land use impacts due to the USA ethanol program using the improved model tuned with actual observations. They showed that, compared to the old model

> The new model projects: (1) less expansion in global cropland, (2) lower share for the USA economy in global cropland expansion, (3) and lower forest share in global cropland expansion.

CARB did not include the model nesting structure changes implemented by Taheripour and Tyner, and recommended by the Expert Working Group, even

though this revised model was available to CARB in early 2013. CARB should include this critical change in the GTAP model.

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Additional Cropland/Pasture Areas in Canada and EU27

GTAP has been updated to include cropland/pasture in the US and Brazil (CARB used the model with these additions). Other regions of the world, such as Canada and the EU27 (and probably many other regions of the world) also have a significant amount of cropland/pasture and idle land. These land areas should be added to GTAP.

LCFS 46-89

Conservation Resource Program Impacts

The GTAP model includes the ability to include CRP land in the land inventory for the US. There has been a significant amount of land converted to production from CRP land in the last seven years. Table 2 shows data from the Conservation Resource Program. [14] These data show over 10 million acres of CRP land have gone back into production. These are not forest acres that have gone into production. Over the period from 2007-2011, CRP acreage in wetlands and buffers increased. Clearly, GTAP should be run to access CRP land in the US prior to converting forests or even cropland/pasture.

LCFS 46-90

[14] "Annual Summary And Enrollment Statistics", FY2011 for 2007-2011, and December 30 Reports for 2012 and 2013, http://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=rns-css.

Table 2. CRP Land Enrolled	
Year	Area (million acres)
2007	36.8
2008	34.6
2009	33.8
2010	31.3
2011	31.1
2012	27.1
2013	25.6

AEZ-EF Model

Use of Carbon Data on Accessible and Inaccessible Forests to Determine Emissions from Forest Conversion

The AEZ-EF report indicates

> The carbon data used in AEZ-EF have been aggregated to GTAP-BIO boundaries, but they include both accessible and inaccessible forests, as well as grasslands other than those used for livestock grazing, and thus represent broader resources than those represented in GTAP-BIO.

LCFS 46-91

It is not clear why CARB is including inaccessible forests in developing forest carbon stocks. If forests are inaccessible, then it is highly unlikely they would be converted to pasture or cropland. CARB should instead develop forest carbon from accessible or commercial forests. Detailed carbon data on public, private, and other forests is utilized by EPA in estimating its annual GHG inventories.[15] The carbon in private forests (most likely of forests to be converted to pasture/cropland) is much lower than public or other forests.

Wood Used to Produce Energy

In the new AEZ-EF model, for forest converted to cropland or pasture, CARB is now accounting for carbon stored in hardwood products (HWP). The storage rates are different for different regions, and are based on a 2012 study by Earles, Yeh, and Skog. The HWP fraction ranges between 2-36%.

LCFS 46-92

In addition to accounting for carbon stored in HWP, CARB should also account for wood mass that is used for fuel during forest clearing. Wood that is burned to

[15] USDA Forest Service (2010a), Forest Inventory and Analysis National Program:User Information. U.S. Department of Agriculture Forest Service. Washington, DC. Available online at http://fia.fs.fed.us/tools-data/docs/default.asp.

produce energy (for a sawmill, for example) is replacing fossil-fueled energy, and is renewable. CARB does not count CO2 emissions from facilities that use waste wood to produce energy for fuel production (CARB does, however, count non-CO2 GHG emissions, which is appropriate). Heath et al estimate that 35% of carbon from forest clearing is used for energy.[16] In the US, Canada, and the EU27, CARB should not count the CO2 from wood used to produce energy.

LCFS 46-92 cont.

CCLUB Model

CARB should consider using the Carbon Calculator for Land Use Change from Biofuels Production (CCLUB) model for estimating emissions.[17] Like AEZ-EF, the model was designed to be integrated with GTAP. It has several advantages over AEZ-EF. First, instead of using the Harmonized World Database (HWD) for soil, it uses the CENTURY model, which contains much more specific information on soil carbon for the US than the HWD, on a county-by-county basis. Second, it uses county-by-county carbon data from forest ecosystems for the US from the Carbon Online Estimator (COLE) database, developed by Van Deusen and Heath in 2010 and 2013. [18,19] Third, it allows the user to input HWP fractions, and fourth, it does not count CO2 from the forest wood used to produce energy. For areas outside of the US, it utilizes Winrock emissions.

CARB has conducted uncertainty analysis of its land use estimates using only AEZ-EF and GTAP. Using the CCLUB model with GTAP to estimate land use change emissions would also provide more information on the uncertainty of CARB's estimates.

LCFS 46-93

[16] L. Heath, R. Birdsey, C. Row, and A. Plantinga. "1996 carbon pools and flux in U.S. forest products", Forest Ecosystems, Forest Management, and the Global Carbon Cycle, M. Apps and D. Price, eds. NATO ASI Series I:Global Environment Changes, Volume 40, Springer-Verlag, ppg 271-278.

[17] See reference 7.

[18] Van Duesen, P., and Heath, L., 2010. Weighted Analysis Methods for Mapped Plot Forest Inventory Data: Tables, regressions, maps and graphs. Forest Ecol. Manage. 260:1607-1612.

[19] Van Duesen, P. and Heath, L. 2013. COLE web applications suite. NCASI and USDA Forest Service, Northern Research Station. Available at http://www.ncasi2.org/COLE/

Updated LUC Modeling

AIR downloaded ARB's GTAP model and the AEZ-EF model to determine the impacts of some of our suggestions. ARB did not supply example run results for any particular biofuel shock. ARB ran the models under 1440 different input conditions, for 5 different biofuel shocks, and determined the average emissions for each of the 1440 runs (a total of 7200 runs). The results are shown in Table 3.

Table 3. ARB Land Use Results, March 11 Workshop	
Biofuel	LUC Emissions (gCO2e/MJ)
Corn Ethanol	23.2
Sugarcane Ethanol	26.5
Soy Biodiesel	30.2
Canola Biodiesel	41.6
Sorghum Ethanol	17.5

In this analysis we test the impact of three factors that should be changed in the ARB modeling:

- ARB's ETL1 and ETL2 values
- Model Nesting Structure
- Price-Yield Range

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It is clearly impractical for us to run the model 1440 times to test the impact of these 3 items. However, it is possible to test the impact with a representative model run. To create the representative model run, we first estimated the average of the ARB inputs. Next, we ran the model with a corn ethanol shock to determine the LUC emissions. Finally, we changed the price yield elasticity, until the model run gave the same answer as corn ethanol in Table 3. The average model inputs are shown in Table 4.

Table 4. Average ARB GTAP Inputs	
Input Parameter	Average Value
Price Yield (Ydel)	0.175
PAEL, US	0.3250
PAEL, Brazil	0.1875
ETA	ARB Baseline
ETL1, ETL2	ARB Baseline

When we ran the case in Table 4, we obtained corn ethanol emissions of 21.66 gCO2e/MJ. We then reduced the price yield elasticity from 0.175 to 0.1507, and obtained emissions of 23.22 gCO2e/MJ, which is the same as ARB's corn ethanol estimate. This is our single run that generally represents CARB's 1440 cases.

The impact of the 3 changes on LUC emissions for the corn ethanol shock are shown in Table 5.

Table 5. Impacts of Changes in GTAP Modeling	
Scenario	LUC Emissions (gCO2e/MJ)
AIR "Representative" Case	23.22
Change ETL1 and ETL2 parameters to Purdue "tuned" values	21.20
Implement Purdue GTAP Nesting Structure	19.00
Use Purdue Default Price-Yield Range	14.63
Include CRP Land Conversions	13.75

Table 5 shows likely emissions of 13.75 g CO2e/MJ instead of 23.22 gCO2e/MJ if these changes are implemented and the various runs are repeated. The emissions would be even lower if the model were modified to more properly reflect (1) the Ray and Foley analysis that a major part of crop production has increased without a land use change, and (2) the ARB analysis properly accounted for wood from forest that is used for fuel and replaces fossil fuel during forest clearing.

LCFS 46-94 cont.

2.0 Fuel Pathways and Producer Facility Registration

Growth Energy supports the streamlining of the application process for biofuel production facilities, however, Growth Energy does not support limiting the pathways a facility can apply for, nor does Growth Energy support implementation of CI "bins" that facilities must use when registering the facilities. These changes would both severely limit continued innovation in biofuel facilities.

LCFS 46-95

At the workshop, CARB envisioned bins of either 5, 7, or 9 CI values, with all facilities falling in a bin range getting the same, midpoint value of the bin. For a 7 CI bin case, for example, facilities falling in a bin from 61-67 would all be assigned a value of 64, whether their CI is 61.1 or 66.9. Furthermore, a facility with an actual CI of 65 (assigned value of 64) would not be able to obtain a lower CI value unless it reduced its actual CI to the upper part of the next bin range, or 60.9 (a difference of 4.1 CI). A facility at 61.1, however, with an assigned value of 64 would be able to get into the next lowest bin by reducing its CI to the same value of 60.9, a difference of only 0.2 CI. Clearly, if we are understanding CARB's bin approach correctly, it appears to have significant problems, no matter how the bins are designed.

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A second major concern we have with the bin approach is that it is not at all consistent with what ARB is proposing for refineries producing gasoline and diesel. CARB's GHG Emission Reductions for Refineries proposal indicates that CARB is willing to provide credit under the LCFS regulations to refineries, with no minimum CI reduction required. In other words, a refinery that has a project to reduce its CI by 0.1 CI would receive consideration. But under the binning approach for

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biorefineries above, there is a much higher minimum threshold for consideration of a lower bin. Thus, gasoline/diesel refineries receive special treatment that biofuel facilities do not.

LCFS 46-97 cont.

Attachment 2

Comments on ARB's September 29th Workshop
On Land Use Change Emissions
Air Improvement Resource, Inc.
October 17, 2014

Introduction

On September 29, 2014 ARB held a workshop on land use change emissions. ARB presented new information on their analysis of LUC emissions for corn ethanol, soybean biodiesel, canola biodiesel, cane ethanol and sorghum ethanol.

We have reviewed the information CARB presented at the workshop and thereafter, and also have obtained the new GTAP model and performed some additional modeling runs. We appreciate the additional time that the staff has provided for us to provide these comments. We will have additional comments later. The comments are presented here are organized into the following sections:

- Irrigated/Rain-Fed Cropland Category
- Land Supply Structure
- ETL11, ETL12, ETL4 and ETL5
- ARB's 30-Scenario Average
- Yield-Price Elasticity
- Cropland Pasture Elasticity
- Corn Ethanol LUC Impacts of our Recommendations

Please add these comments to the page on ARB's website that has been previously established for workshop comments.

Irrigated/Rain-fed Cropland Category

Earlier versions of the GTAP model used an average of irrigated and rain-fed cropland. The expansion of cropland in the model did not differentiate between irrigated or rain-fed areas. Irrigated cropland typically has a higher yield compared to rained cropland in a given Region and AEZ. If cropland expansion occurs on irrigated land, higher yields translate into smaller land requirements. But availability of water for irrigation may limit expansion into irrigated land.

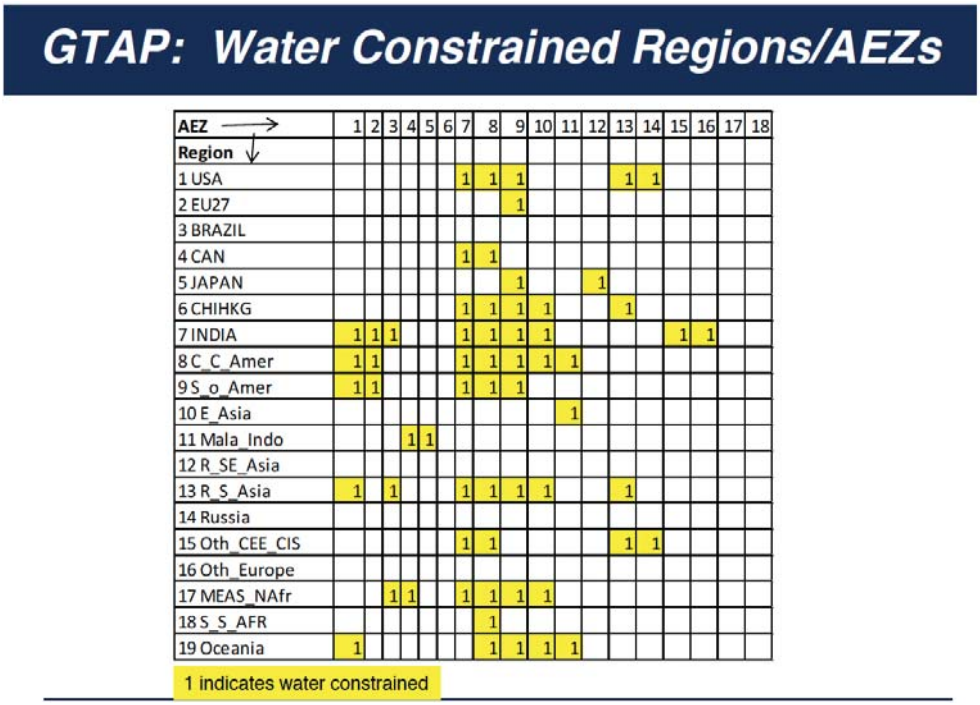
The new version of GTAP developed by Purdue for ARB includes an option to differentiate between irrigated and rainfed cropland. The availability of irrigated land for cropland expansion then can be constrained in certain regions and AEZs, if there is sufficient evidence to constrain expansion of irrigated lands.

ARB used analyses and data from the World Resources Institute (WRI) to determine which regions and AEZs within these regions to constrain expansion into irrigated land.

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Figure 1 shows the Regions and AEZs where irrigated land is constrained for the ARB LUC analyses. These regions and AEZs were determined from the WRI reports. [2021]

Figure 1



AEZ → / Region ↓	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 USA							1	1	1				1	1				
2 EU27									1									
3 BRAZIL																		
4 CAN							1	1										
5 JAPAN									1			1						
6 CHIHKG							1	1	1	1			1					
7 INDIA	1	1	1				1	1	1	1					1	1		
8 C_C_Amer	1	1					1	1	1	1	1							
9 S_o_Amer	1	1					1	1	1									
10 E_Asia											1							
11 Mala_Indo				1	1													
12 R_SE_Asia																		
13 R_S_Asia	1		1				1	1	1	1			1					
14 Russia																		
15 Oth_CEE_CIS							1	1					1	1				
16 Oth_Europe																		
17 MEAS_NAfr			1	1			1	1	1	1								
18 S_S_AFR								1										
19 Oceania	1							1	1	1	1							

We reviewed the WRI reports, but were unable to determine how ARB used the information in these reports to identify the regions and AEZs that should have irrigated land constrained. Because we have been unable to locate the technical documentation that would explain how ARB used the WRI reports to draw the conclusions shown in Figure 1, we request that the staff provide the public with that documentation, and then allow at least five business days for comment.

ARB presented little information at the workshop to evaluate the size of this impact on land use emissions. To evaluate the impact of constraining expansion on irrigated land, AIR ran GTAP with and without the irrigation constraint for corn ethanol, using Purdue and ARB's average elasticity inputs. The results are shown in Table 1.

LCFS 46-98 cont.

[20] *Aqueduct Global Maps 2.1: Constructing Decision-Relevant Global Water Risk Indictors*, WRI, April 2014.

[21] *A Weighted Aggregation of Spatially Distinct Hyrdrological Indicators*, WRI, December 2013.

Table 1. LUC Impact of Constraining Crop Expansion on Irrigated Land in Some Areas: Corn Ethanol					
Scenario	Ydel	PAEL	ETA	Irrigation Constrained?	LUC (gCO2e/MJ)
Purdue Best Estimates	0.25	0.4/0.2	Baseline	No	14.23
				Yes	13.32
ARB Average	0.19	0.3/0.15	Baseline	No	17.22
				Yes	16.09

LCFS 46-98 cont.

For corn ethanol, constraining expansion on irrigated land adds 0.89 g/MJ for the Purdue default case, and by 1.13 g/MJ for the ARB average. ARB must document how the WRI data was used to develop areas on which cropland cannot be expanded, before including this effect for the various biofuel feedstocks.

Land Supply Structure

The land supply structure in GTAP was revised in 2013 to include four nesting structures instead of two.[22] Prior to 2013, one nest included the substitution of different types of land – forestland, cropland, and pastureland – and a second nest under cropland that included different types of crops. One elasticity – ETL1 – governed the substitution between forestland, cropland, and pastureland, and a second elasticity – ETL2 – governed the substitution between crop types. A significant concern of ARB's Expert Working Group (EWG) was that forestland, cropland, and pastureland were all in the same nest with one elasticity, which meant that forestland is as readily converted to cropland (and vice versa) as pastureland. Clearly this is not the case – the economics of converting forest to crops must be much different than converting pasture to crops.

In 2013, the land supply structure was modified by Purdue such that the first nest includes only forestland and a second category called cropland+pasture. The second nest under cropland+pasture was divided into cropland and pastureland. The third nest under cropland was divided into irrigated and rain-fed. Finally, both irrigated and rain-fed cropland was divided into different crops. The following new elasticities were defined:

LCFS 46-99 cont.

- ETL11: substitution at the first level between forest and cropland+pasture
- ETL12: substitution at the second level between cropland and pasture
- ETL2: substitution between irrigated and rain-fed
- ETL4: substitution between crops under irrigated land
- ETL5: substitution between crops under rain-fed land

The new land supply structure allows the use of more disaggregated elasticities of transformation between land types.

ARB modeled two approaches in estimating land use emissions – Approach A, which assumes ETL11=ETL12, and Approach B, which provides separate estimates for ETL11

[22] See reference 13.

and ETL12. Approach A is essentially the GTAP model prior to the land supply improvements (i.e., only 1 elasticity which governs conversion of forest, crop, and pasture), while Approach B is the GTAP model with the improvements (expanded nesting supply structure). Elasticity values for Approaches A and B are shown in Attachment 1. In both approaches, the ETL2 values are identical; it is only the ETL11 and ETL12 values that are different between the approaches.

ARB did not implement Approach B in its materials presented at the March 11, 2014 workshop, in spite of the fact that GTAP was updated for land supply structure more than a year ago in January 2013. One of Growth Energy's primary comments on the materials ARB supplied at the March 11 workshop was that ARB should utilize a GTAP model with the updated land supply structure with different elasticities of conversion for forest and pasture. (i.e., Approach B). Approach A must be recognized as unrealistic, and not appropriate for use in the new regulation to set the indirect emissions factor for land use change attributed to biofuel expansion. Approach A is *not* an equally technically appropriate alternative to Approach B. Purdue no longer utilizes Approach A – it is simply now an approach that tries to mimic the old GTAP model prior to the significant improvements made in early 2013.

LCFS 46-99 cont.

ETL11, ETL12, ET4, ETL5

ARB's ETL11, ETL12, ETL4, and ETL5 values for Approach B were presented in Slide 24 of the September 29 presentation. Based on the information that is currently available, we believe those values are more appropriate than some alternatives.

LCFS 46-100

ARB's 30-Scenario Average LUC Emissions

In the March 11 workshop, ARB modeled 1440 separate scenarios for each biofuel, and averaged the results of these scenarios to estimate LUC for each biofuels. In the September 29 workshop, Staff had reduced this to 30 separate GTAP runs, varying 3 separate input elasticities: the yield price elasticity (YPE, or Ydel), the cropland pasture elasticity (PAEL) for the US and Brazil, and the elasticity of crop yields with respect to area expansion (ETA). There are five values for Ydel, 2 for PAEL, and 3 for ETA (5*3*2 = 30).

Growth Energy has commented previously that the number of runs should be reduced (and they have), and further support doing GTAP runs at varying elasticities, since these can affect the results. (See Attachment 2.) However, we believe that ARB has selected the wrong range of values to use for two of the input elasticities.

It is worth noting that Purdue has "best estimates" for each of these inputs. The ARB input values and Purdue best estimates are shown in Table 2.

LCFS 46-101

Table 2. ARB Input Elasticities Compared to Purdue Best Estimates				
Parameter	Description	ARB Values	ARB Average Value	Purdue Best Estimate
YPE	Yield Price Elasticity	0.05, 0.125, 0.175, 0.25, 0.35	0.19	0.25
PAEL	Cropland pasture elasticity*	0.2/0.1, 0.4/0.2	0.3/0.15	0.4/0.2
ETA**	Elasticity of crop yields with respect to area expansion	Baseline, 80% of baseline, 120% of baseline	Baseline	Baseline

*The first value is for the US, the second for Brazil
** ETA varies by region. The baseline values used by ARB are the same as used by Purdue

For YPE, the ARB range is from 0.05 to 0.35, with an average value of 0.19. The range in the March 11 workshop was from 0.05 to 0.30, so ARB has increased the upper end of this range by 0.05. The average value is lower than the Purdue best estimate of 0.25, and lower values yield to higher land use emissions. For PAEL, ARB selected the ARB best estimate and an estimate one-half of that. The average of the two ETA values for Brazil and the US is lower than the Purdue best estimate. Again, lower values lead to higher land use emissions. Finally for ETA, ARB selected the Purdue best estimate as the central value, and values higher and low than the best estimate. The average of the three is at the Purdue best estimate.

For PAEL, ARB seems to have followed the methodology of selecting values higher than and lower than the Purdue best estimate. This approach makes sense to us. However, for YPE and ETA, ARB selected values rather arbitrarily that yield an average value that is significantly different than the Purdue best estimate. ARB has not presented reasons or a rationale why it did this, so it appears they did this for the sole purpose of increasing the land use emissions of crop-based biofuels. We therefore ask that ARB explain those reasons to the public and allow at least five business days for comment. Because ARB must use the best available scientific information when writing its greenhouse gas regulations, we believe that ARB needs to explain why, if it maintains the current approach, it believes that its approach is scientifically superior and uses the best available scientific data.

We present the impacts of this arbitrary decision making process later in these comments.

LCFS 46-101 cont.

Yield Price Elasticity (YPE, also Ydel)

In our comments on the previous workshop, we indicated that GTAP is a medium term model, and that YPE values developed over the very short term were not appropriate -- as previously noted, ARB is required to use the best available scientific information under the 2006 law that applies here. The values below 0.15 referenced by ARB were short-

LCFS 46-102

term values, therefore, ARB should not be using values below 0.15 (i.e., 0.05 and 0.125), as they are not consistent with GTAP's general timeframe.

In addition, in our previous comments we presented information showing that Purdue's best estimate value of 0.25 does not include double-cropping, conversion of fallow land to cropland in the US, Canada and the EU27 regions, and conversion of Conservation Reserve Program (CRP) land in the United States.[23] We presented significant, substantial and compelling evidence on the conversion of fallow land and CRP land in those comments. CRP land is in the GTAP land supplies and could be utilized directly. We pointed out that both double cropping and fallow land conversion could be simulated with higher Ydel values (i.e., values above 0.25).

As indicated in the previous section, ARB used two values below 0.15 – 0.05 and 0.15. We believe these should be dropped from the Ydel analysis since they are not consistent with GTAP. Second, we believe ARB should expand the upper limit of Ydel to 0.50. The values we are recommending are 0.15, 0.2, 0.25 (Purdue best estimate), 0.3, and 0.5. The average of these values is 0.28, which is only 0.03 above the Purdue best estimate, and a reasonable conservative average to reflect a small amount of double cropping and/or fallow land conversion. If the staff does not agree, we ask that it explain why in a manner that we and other interested parties can address in a timely manner, and that the staff can consider before it proposes the new regulation.

LCFS 46-102 cont.

Cropland Pasture Elasticity (PAEL)

ARB used the Purdue best estimate (0.4/0.2) and one-half of the best estimate (0.2/0.1). There is no information given on why ARB used one-half of the Purdue best estimate without also using something above the Purdue best estimate, for example, 0.6/0.3. The purpose of sensitivity analysis is determine how the model inputs affect the results. Using a sensitivity analysis on only the "low" side of the Purdue best estimate skews the land use values higher, and is not consistent with scientific norms or the requirement to use the best available scientific information. We recommend running three PAEL values, where one is the Purdue best estimate and the other two are higher and lower than the Purdue best estimate. If the staff does not agree with that recommendation, we ask that it fully explain why it is not doing so, in time for the public to comment

LCFS 46-103

Corn Ethanol LUC Impacts of our Recommendations for Elasticity Inputs

The time allowed by the staff to prepare these comments did not permit us to run all of CARB's 30 cases to establish a baseline, but instead, we ran the average of the elasticity inputs, and the high and low. Results are shown in Table 3 compared to ARB's results of

LCFS 46-104

[23] Double cropping refers to the practice of growing two crops on the same land in the same season. For example, often corn or soybeans are grown after winter wheat on the same land in the US. In Brazil, because the growing season is longer, often corn is grown after soybeans. The Conservation Reserve Program is a cost-share and rental payment program under the United States Department of Agriculture (USDA), and is administered by the USDA Farm Service Agency (FSA). The CRP encourages farmers to convert erodible cropland or other environmentally sensitive acreage to vegetative cover.

the 30 runs. As shown in Table 3, values generated by us are lower than ARB's values. The reasons for this are not clear. Our program files have been provided to the staff for these cases for review. For now, we have also constrained expansion on irrigated land, even though we have not had a chance to review the method ARB used to incorporate data and information from the two WRI reports.

Table 3. ARB Average, Low and High LUC Emissions for Corn Ethanol (Approach B with Irrigation Constrained)

Case	Ydel	PAEL	ETA	AIR LUC gCO2e/MJ	ARB LUC gCO2e/MJ
Average of ARB Inputs	0.19	0.3/0.15	Baseline	17.22	21.6
ARB "High"	0.05	0.2/0.1	80% of Baseline	34.49	37.0
ARB "Low"	0.35	0.4/0.2	120% of Baseline	9.68	11.5

Basically, we are recommending that ARB use the Purdue best estimates for elasticity inputs, except for Ydel, which we believe should average about 0.28 or so to reflect some double-cropping which typically takes place in Brazil and also in the US and other areas, and also conversion of some fallow land in the US, Canada, and the EU27, at a minimum. We have estimated emissions by utilizing average input parameters, instead of making 45 runs; but acknowledge that it would be more precise to perform the 45 runs and determine average emissions, since some of the effects are likely not to be linear.[24] Results are shown in Table 4.

LCFS 46-104 cont.

Table 4. ARB Average and Recommended Values for Corn Ethanol (Approach B with Irrigation Constrained)

Case	Ydel	PAEL	ETA	LUC (gCO2e/MJ)
Average of ARB Inputs	0.19	0.3/0.15	Baseline	17.22
Purdue Best Estimate	0.25	0.4/0.2	Baseline	14.23
AIR Recommended*	0.28	0.4/0.2	Baseline	13.23

* We recommend performing the 45 runs and determining the average emissions, which may differ from 13.23 g/MJ.

The LUC with the Purdue best estimate inputs is 14.23 gCO2e/MJ. Our recommendation results in LUC emissions of 13.23 gCO2e/MJ, based on these inputs. Here again, we would like to know if the staff agrees with this recommendation, and, if not, we request an explanation why it does not agree in time for us to provide further input, that the staff can consider as it develops the new regulatory proposal.

[24] 45 = 5 Ydel values (0.15, 0.2, 0.25, 0.3, 0.5), 3 PAEL values (0.2/0.1, 0.4/0.2, 0.6/0.3), and 3 ETA values (baseline, 80%, 120%).

Attachment 3

Comments on November 20 ARB iLUC Workshop
Air Improvement Resource, Inc.
December 4, 2014

Introduction

On November 20 ARB held a third workshop on indirect land use (iLUC) emissions of various biofuels. New land use emission values were presented by the Staff. A summary of the emissions for corn ethanol from the different workshops is shown in Table 1. The emissions of corn ethanol dropped slightly from 21.6 g/MJ to 20 g/MJ.

Table 1. Corn Ethanol iLUC Values (gCO2e/MJ)

Biofuel	Current Regulation	March 2014	September 2014, Approach B	November 2014, Approach B
Corn Ethanol	30.0	23.2	21.6	20.0

Very little new information was presented at this workshop. One decision that ARB made was to use GTAP "Approach B" in estimating land use emissions. Putting to the side numerous other issues related to the iLUC analysis being undertaken by the Staff and stakeholders, the use of "Approach B" is an improvement worthy of support, because it makes the GTAP model ARB is using consistent with the GTAP model developed by Purdue that is described in detail in the January 2013 Applied Science report by Purdue.[25] This approach uses separate elasticities of transformation of Forest-to-Crops and Pasture-to-Crops.

LCFS 46-105

ARB made some changes in the AEZ-EF model, but as of November 30 has not released the AEZ-EF model for review and comment. As a consequence, we cannot comment on this model until it is provided for review. In order to permit effective participation in the rulemaking, ARB should make the model fully available without further delay. Waiting until the 45-day process is not appropriate given the complexity and importance of the issues that the AEZ-EF model is supposed to address.

ARB's price-yield elasticity range stayed the same as the previous workshop. According to ARB, this decision was based on a study by UC Davis. However, the UC Davis study was also not made available, so it is impossible to comment on that decision. ARB should provide public access to the relevant study and supporting materials without further delay. Consequently, our comments on price-yield remain the same as they before, i.e., that ARB should disregard th`e two lowest price-yield

LCFS 46-106

[25] See reference 13.

elasticities it is currently using, and use somewhat higher price-yield elasticities, so that the average price-yield elasticity is around 0.28 or 0.30, in order to reflect multiple cropping in some countries. Our previous comments on the September 29 workshop that discuss price-yield in more detail are included as Attachment 1 to this document.

LCFS 46-106 cont.

This document summarizes our further comments on the workshop and ARB's current land use estimates. It is important to note at the outset that shortly before the workshop, a significant report on using recent land use change data to validate land use change models was released by Iowa State University.[26] The study has important implications for ARB's current land use emission estimates, and thus, important implications for the overall lifecycle emissions of various biofuels as compared to petroleum-derived fuels. In response to a question from a workshop participant, ARB indicated that they had a copy of this study and were reviewing it. We believe that the Staff should address the new study in the ISOR and provide it to the peer reviewers who will be engaged to examine iLUC issues. The ISU report's findings must be used by ARB in conjunction with ARB's GTAP modeling to derive new and updated land use emission estimates for the various biofuels prior to proposing re-adoption of the Low Carbon Fuel Standard (LCFS). Failure to do this would mean that ARB would not be using the latest and best available scientific and economic information to develop its lifecycle emissions for biofuels, which we understand to be required by the governing statute, A.B 32.

LCFS 46-107

Our comments are organized in the following sections:

- Summary of the Babcock/Iqbal study
- Impacts on ARB's iLUC estimates for corn ethanol
- Other Comments

<u>Summary of Babcock/Iqbal Study</u>

The study developed new methods of using existing land cover data to evaluate the extent of land transitions in the time period between 2004-2006 and 2012-2014, the time period of fairly rapid expansion of biofuel in the US. These were compared to both the FAPRI and GTAP model estimates. In short, the paper concludes that the models used by EPA and ARB significantly overestimate pasture and forest conversions to crops in many parts of the world (including the US), because they do not include land "intensification", which includes increased double-cropping, reduced fallow land, and reduced land that is planted but not harvested (in other words, increasing the harvested to planted ratio). The authors purposely did not consider crop yield improvements, which is another form of intensification and, which if also included, would further reduce iLUC GHG estimates. [27]

LCFS 46-108

[26] See reference 5.

[27] Land "extensification" means conversion of forest and pasture to cropland, whereas "intensification means making existing land (cropland and idle or fallow land) more productive.

The paper first summarizes annual inflation-adjusted price changes in a number of crops from 1965 to 2012, and shows that prices of a number of key crops increased for a number of years from 2004-2012. The paper cites another study by Babcock and others that opines that about one-third of the corn price increase during this time period was due to the biofuel mandate (RFS), other factors such as crop shortfalls and other sources of increased demand account for the rest of the price increase. The reason for showing these price trends was that "the magnitude of these real price increases after such a prolonged and sustained period of flat or falling prices presents a unique opportunity to quantify how world agriculture responds to incentives to produce more." The paper goes on to state that "because indirect land use is a response to higher market prices, model predictions of land use change should be similar whether the higher prices came from increased biofuel production, increased world demand for beef, or from drought that decreased supply. This implies that the pattern of actual land use changes that we have seen since the mid-2000s should be useful to determine the reliability and accuracy of model that have been used to measure indirect land use."

The study then examines changes in "harvested land" between the two periods. The source of this information is the Statistics Division of the Food and Agriculture Organization of the United Nations (FAOSTAT).[28] These data have been widely used to measure the impact of biofuel production on expansion of land used in agriculture and to calibrate the land cover change parameter in the GTAP model used by ARB. [29,30] But the study points out that harvested land is not equal to planted land, and that harvested land will deviate from planted land "when a portion of planted land is not harvested, and when a portion of land is double or triple- cropped." The study examines data from specific countries, and shows that existing land intensification has accounted for 76% of the increase in production in Brazil, and nearly all of the increase in production in India and China.

LCFS 46-108 cont.

An alternative measure of land use is developed, which is the change in FAO's arable land plus permanent crops. Figure 8, which plots the changes in this metric from 2004-2006 to 2012-2014 from the report, is shown below. The report states: "The countries in Figure 8 that either had negligible or negative extensive land use changes should be presumed to not have converted pasture or forest to crops in response to biofuel-induced higher prices. Rather, the presumption should be that any predicted change in land used in agriculture came from cropland that did not go out of production." The regions in Figure 8 with negligible or negative extensive land use changes are: Rest of Asia, the European Union, Canada, Russia, Oceania, China, South Africa, India, Central and Caribbean America, Bangladesh, Japan, Rest

[28] http://faostat3.fao.org/home/E

[29] Roberts and Schlenker, "Identifying Supply and Demand Elasticities of Agriculture Commodities: Implications for the US Ethanol Mandate", American Economic Review 103(6): 2265-95

[30] See footnote 1.

of East Asia, Other Europe and Remainder of Former Soviet Union, Ukraine, and the US.

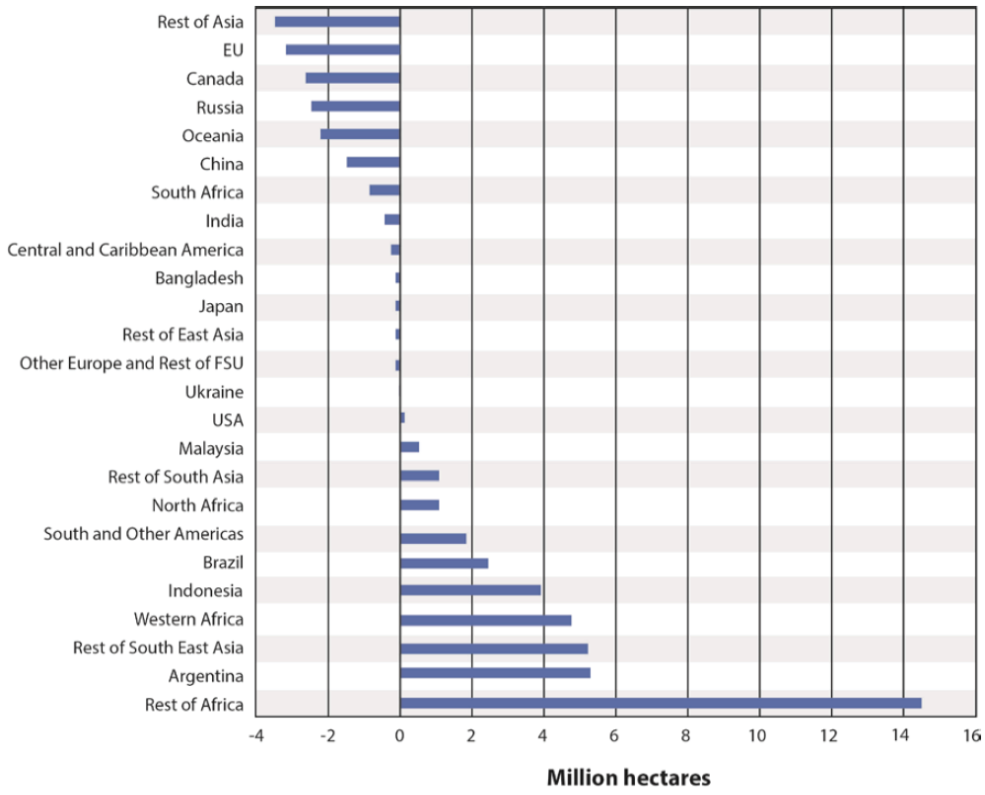


Figure 8. Change in Arable Land Plus Permanent Crops: 2004–2006 to 2010–2012

Figure 8 does show that Western Africa, and the "Rest of Africa", have significant extensive changes in arable land plus permanent crops (see Attachment 2 for countries included in the Africa regions of Figure 8). However, the study indicates that "the extent to which extensive expansion in African countries was caused by high world prices is small for the simple reason that higher world prices were not transmitted to growers in many African countries. Babcock and Iqbal cite a number of studies to support this conclusion.

LCFS 46-108 cont.

Impacts of Babcock/Iqbal Study on ARB's ILUC Estimates for Corn Ethanol

As indicated earlier, we do not have ARB's most recent AEZ-EF model so we cannot replicate ARB's 20 g/MJ value for corn ethanol (the 20 g/MJ value is an average based on 30 individual runs of the GTAP model, coupled with the AEZ-EF model). We can, however, use GTAP runs with the ARB GTAP model and AEZ-EF model ARB released as a part of the September 29th workshop to develop an estimate of the impact of Babcock/Iqbal's recommendations.

The primary conclusion from the Babcock/Iqbal study is that there are regions/countries of the world that had negative or negligible extensive land use changes between 2004-2006 and 2012-2014, and these countries and regions should be presumed not to have any forest or pasture conversion to cropland in response to biofuel expansion. The countries and regions in this category were listed earlier. Other countries not on this list can still be presumed to have some extensive land use conversions (i.e., conversion of forest and pasture to crops). Thus, the Babcock/Iqbal study can be used as a filter on the existing GTAP results.

Table 2 shows our GTAP modeling from our comments on the September 29 workshop (found in Table 4 of that report). We show the iLUC for 3 cases:

LCFS 46-108 cont.

- Average of ARB inputs
- Purdue best estimate
- AIR recommended inputs

Table 2. ARB Average and Recommended Values (Approach B with Irrigation Constrained) for Corn Ethanol

Case	Ydel	PAEL	ETA	AIR Estimated LUC gCO2e/MJ
Average of ARB Inputs	0.19	0.3/0.15	Baseline	17.22
Purdue Best Estimate	0.25	0.4/0.2	Baseline	14.23
AIR Recommended*	0.28	0.4/0.2	Baseline	13.23

The case with the "Average of ARB Inputs" is 17.22 gCO2e/MJ. This is less than ARB obtained with its average of the 30 scenario runs (21.6 gCO2e/MJ), but nonetheless, we can use this case to estimate the impacts of applying the country/region filter from the Babcock/Iqbal analysis.

Table 3 shows emissions from land transitions for the ARB average case. As shown in the table, Forest-to Crop transitions comprise 60% of emissions, and Pasture-to-Crop transitions comprise 21% of emissions.

Table 3. Land Transition Emissions for the ARB Average Case	
Land Transition	ARB Average, Megagrams CO2e
Forest-to-Crop	305,579,609
Pasture-to-Crop	109,196,645
Cropland-pasture to Crop	114,309,541
Crop-to-Forest	0
Crop-to-Pasture	0
Crop-to-Cropland pasture	0
Pasture-to-Forest	-20,801,279
Forest-to-Pasture	124,717
Total	508,409,234

The breakdown of Forest-to-Crop and Pasture-to-Crop emissions by GTAP region for the ARB average case are shown in Table 4. We have not shown areas with less than 1% contribution. We also have bolded the regions that Babcock/Iqbal indicate would not have Forest-to-Cropland or Pasture-to-Cropland transitions. (Our mapping of the Babcock/Iqbal regions which come from FAOSTAT, to the GTAP regions is shown in Attachment 3.)

We have shaded the sub-Sahara region[31] for several reasons – (1) GTAP predicts it is the largest contributor to emissions for the corn-ethanol expansion, (2) the Babcock/Iqbal analysis shows that the country of South Africa, part of sub-Sahara Africa, should not have forest to crop and pasture to crop transitions, and (3) we are not sure how to separate South Africa from the sub-Sahara region in GTAP, and (4) the Babcock/Iqbal report also indicates that the expansion of cropland from forest and pasture in many African countries is not price-induced.

Thus, on one hand, Babcock/Iqbal are making the case that the extensive land changes in Africa are not price driven, and therefore, not related to biofuel expansion, and so in one case the sub-Saharan region can be omitted from the corn ethanol emissions analysis. On the other hand, if these countries are included in the emissions analysis because they do have extensive land use changes, the emissions will be over-predicted because of our current inability to remove South Africa from the sub-Saharan region. Nonetheless, we will estimate iLUC emissions for these two cases – one without sub-Sahara Africa, and one with.

LCFS 46-108 cont.

[31] The sub-Sahara region in GTAP includes Botswana, South Africa, Rest of South African Customs Union, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe, Rest of South African Development Community, Madagascar, Uganda, and rest of sub-Saharan Africa.

Table 4. Regional Forest-Crop Plus Pasture-Crop Transition Emissions for ARB Average		
Region	Megagrams	Percent of Total Forest-to-Crop and Pasture-to-Crop Emissions
USA	**43,316,687**	**10%**
EU27	**15,681,094**	**4%**
Brazil	56,258,521	14%
Canada	**14,911,705**	**4%**
Japan	**3,745,849**	**1%**
China + Hong Kong	**16,121,420**	**4%**
India	**7,732,753**	**2%**
South America (w/o Brazil)	14,930,904	4%
Rest of Southeast Asia	13,248,332	3%
Rest of South Asia	5,810,952	1%
Other CEE_CIS	**7,867,793**	**2%**
Mideast North Africa	**2,629,014**	**1%**
Sub-Sahara Africa	**204,901,423**	**49%**
Oceania	2,628,749	1%

LCFS 46-108 cont.

The results of our analysis of iLUC emissions for the ARB average case, with and without sub-Sahara Africa being included with the other areas without Forest-to-Crop and Pasture-to-Crop transitions, is shown in Table 5. Application of the Babcock/Iqbal analysis reduces iLUC emissions between 21% and 65%, depending on the treatment of emissions in sub-Sahara Africa. The range for corn ethanol for the Purdue Best Estimate (input elasticities) is between 5 and 11 g CO2e/MJ, far lower than ARB's current 20 g CO2e/MJ estimate.

Table 5. Impacts of the Babcock/Iqbal Filter on GTAP Results (g/CO2e/MJ)		
Scenario	ARB Average	Purdue Best Estimate
No Filter (from Table 2)	17.2	14.2
Filter without sub-Sahara impacts	13.3 (-21%)	10.9 (-22%)
Filter with sub-Sahara impacts	6.1 (-64%)	5.0 (-65%)

ARB should revise its iLUC emissions for various biofuels to account for the Babcock/Iqbal analysis. The reasons why emissions are lower with application of their analysis are not new – they are related to multiple cropping in certain regions, the use of idle or fallow land, and the improvement in harvested versus planted land,

which are all related to higher prices for commodities. None of these items is currently included in the GTAP model that ARB is using.

LCFS 46-108 cont.

Other Comments on the Workshop

Price-Yield Elasticity

As indicated earlier, ARB has stated its intent to use its current price elasticity range, with an average elasticity of 0.19. The Purdue estimate is 0.25, and it does not account for double-cropping or other intensification measures used by the agriculture industry. We have been recommending a price-yield elasticity range of 0.2-0.5, with an average of 0.28, slightly higher than the Purdue best estimate, to account for some multiple cropping. After reviewing the Babcock/Iqbal analysis, we think the best way to account for multiple cropping in the short term is by applying the Babcock/Iqbal filter. Therefore, if ARB were to utilize the Babcock/Iqbal filter on its results, the price-yield range should be modified to have an average of 0.25 at the Purdue best estimate. We do not support ARB's current range, because the lower end of the range is based on very short-term price-yield studies, and GTAP is a medium to long-term model.

LCFS 46-109

Conservation Reserve Program Land (CRP) in the US

We have submitted comments showing that a large amount of ex-CRP land appears to have come into production in the US in the last 7 years (see page 5 in Attachment 3).[32] The GTAP model is capable of accessing this land, but in the ARB version of the model the option to access this land within GTAP has been turned off. It is very straightforward to turn this option on. The Babcock/Iqbal study also identifies ex-CRP land as a factor in confirming that there has been no forest or pasture transformations to cropland in the US (see pages 29-30 of the study). Implementation of the CRP land option in GTAP reduces emissions for the ARB average case from 17.22 gCO2/MJ to 16.35 g CO2e/MJ.

If ARB decides to use the Babcock/Iqbal study as a filter to determine regions with forest to crop and pasture to crop transitions, then there is no need to modify GTAP to access CRP lands. However, if ARB decides not to use the Babcock/Iqbal study as a filter, then the GTAP modeling used by ARB should allow the model to access CRP land, because that is what has already happened.

LCFS 46-110

Cropland/Pasture Elasticity (PAEL)

In its modeling scenarios, ARB is only examining cropland/pasture elasticity values of 0.2/0.1 (US/Brazil) and 0.4/0.2. The 0.4/0.2 levels are Purdue's default or best

LCFS 46-111

[32] "Comments on ARB's March 11 Workshop on The Low Carbon Fuel Standard, Air Improvement Resource Inc., April 6, 2014 (provided in Attachment 4).

estimate. So, ARB is examining the Purdue best estimate and one-half that level (lower levels increase the iLUC emissions).

We indicated in our comments on the September 29 workshop and also in the November 20 workshop, that ARB should estimate emissions for three PAEL levels for the US and Brazil. Two of the levels are the same as the ARB's current levels, the third one is 0.6/0.3. ARB had previously planned on using the 0.6/0.3 values. In response to our question as to why PAEL levels of 0.6/0.3 were dropped from the analysis, ARB indicated that there was a problem with the run, and promised further information on this. To date, we have not seen that information.

We therefore ran the 0.6/0.3 case using the ARB average price yield elasticity of 0.19 and the baseline ETA value. We encountered no problems with the run, and obtained emissions of 15.55 gCO2e/MJ (as compared to 17.22 g/MJ for the ARB average case using PAEL levels of 0.3/0.15). We therefore recommend that ARB re-instate the 0.6/0.3 PAEL case in its scenario runs, or explain in detail what its concerns are with this case.

LCFS 46-111 cont.

Longer-Term Items

ARB appears to have only 4 items on its agenda for longer-term study (see page 29 of the November 20 workshop handout):

- Address forestry issue in the model
- Account for fertilizer, livestock, and paddy rice emissions
- Include analysis for cellulosic feedstocks
- Develop and validate dynamic GTAP model

Notably absent from this list are all the items which Babcock/Iqbal identify as primary drivers of less Forest-to-Crop and Pasture-to-Crop transitions (and thus the overall iLUC emissions of biofuels) in many regions of the world, such as (1) multiple cropping (double- and even triple-cropping), (2) use of temporary fallow/idle land, (3) less land that is planted and not harvested, and (4) the use of CRP land in the US. In addition, stakeholders reviewing ARB's iLUC estimates have made numerous comments about multiple cropping, the use of CRP, idle land, etc. Many of these items were identified 4-5 years ago by various stakeholders. None should be deferred from action in the current rulemaking, if ARB's intent is to use the best available scientific information and analysis, as A.B. 32 requires.

LCFS 46-112

The amount of temporary or fallow land can actually be computed from the GTAP land cover. In GTAP there are two layers of information on cropland; land cover and harvested area. Any land which has been cultivated in the past is included in the cropland category under the land cover header. This category of land includes all types of cropland (cultivated and idled land such as planted but not harvested, cropland-pasture, CRP, or fallow). The cropland area is generally not divided into different types (except partially

LCFS 46-113

for the US and Brazil). The second layer is harvested area. Harvested area refers to the cropland that is harvested in the base year (i.e. 2004).

LCFS 46-113 cont.

The version of GTAP used by CARB has cropland-pasture for the US and Brazil and CRP area for the United States added to the harvested land layer. The model does not allow conversion of CRP land to crop production (the model keeps it under the conservation program). However, cropland-pasture which is used for grassing tasks can be converted back to crop production. Cropland-pasture in the other regions of the world and fallow land (either deliberately not planted or having a harvest failure) are not included in the harvested land layer. The model currently has no capability of accessing this land for increased crop production even though it is probably the most likely land to respond to higher crop demand and is land that could be brought into production without any land use change.

LCFS 46-114

In some areas of the world two or more crops can be harvested from the same land in a given year. In these areas, the harvested land may be greater than the cropland area. While some regions may have both fallow land and double-cropped land from this data we can only show the net fallow land (i.e., net cropland not in crops) and the net double-cropped land. A summary of these lands by model region is shown in Table 6.[33]

[33] Darlington, Kahlbaum, O'Connor, and Mueller, "Land Use Change Greenhouse Gas Emissions of European Biofuel Policies Utilizing the Global Trade Analysis Project Model, August 30,2013.

Table 6. GTAP Land Summary (Ha)				
GTAP Region	Cropland	Harvested Area	Net Cropland Not in Crops	Net Double-Cropped
USA	175,807,007	167,059,000	8,748,007	
EU27	124,830,687	115,729,000	9,101,687	
BRAZIL	60,724,257	86,403,000		-25,678,743
CAN	39,573,515	33,514,000	6,059,515	
JAPAN	3,680,435	4,185,000		-504,565
CHIHKG	140,644,611	160,840,000		-20,195,389
INDIA	171,418,998	186,799,000		-15,380,002
C_C_Amer	56,671,461	26,687,000	29,984,461	
S_o_Amer	58,603,527	56,585,000	2,018,527	
E_Asia	5,190,174	4,852,000	338,174	
Mala_Indo	71,571,068	35,999,000	35,572,068	
R_SE_Asia	53,207,433	60,163,000		-6,955,567
R_S_Asia	46,956,517	43,712,000	3,244,517	
Russia	124,542,334	81,229,000	43,313,334	
Oth_CEE_CIS	111,522,274	94,998,000	16,524,274	
Oth_Europe	933,565	1,160,000		-226,435
MEAS_NAfr	53,633,308	49,933,000	3,700,308	
S_S_AFR	211,016,073	175,792,000	35,224,073	
Oceania	33957545	42,181,000		-8,223,455
Total	1,544,484,789	1,427,818,000	193,828,945	-77,164,156

In addition, ARB currently assumes that cropland-pasture that is converted to cropland experiences 50% of the emissions of conversion of permanent pasture. This is strictly an assumption. Purdue currently estimates conversion of cropland-pasture has the same emissions as crop-to-crop conversions. This should also be a focus of future research.

LCFS 46-114 cont.

17_OP_ADF_GE Response (Page 55 – 90)

100. Comment: **LCFS 46-78 through LCFS 45-114**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Regulation Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

Appendix B

Comments on the CA-GREET 2.0 Model
February 10, 2014

ARB staff released a draft report comparing GREET1.8b, GREET12013, and CA-GREET 2.0 on October 10. In addition, staff released the GREET 2.0 model for comment. AIR has reviewed some aspects of this model, and offers comments in the following areas:

- GREET2014
- Denaturant Modifications for Ethanol
- DGS Reduced Enteric Emissions Credit

In addition to the above, Professors Bruce Dale and Seungdo Kim reviewed the agricultural chemical and ethanol plant chemical emissions for both corn and cellulose ethanol. Their comments are included in Attachment 1 to this document.

Our combined reviews indicate that ARB has overestimated the direct emissions of both corn ethanol and ethanol made from stover. The implications of overestimating the lifecycle emissions for corn and stover ethanol are that it could lead to shuffling of fuels without any reduction in greenhouse gases and increased costs of compliance with the LCFS. **LCFS 46-115**

<u>GREET2014</u>

The CA-GREET 2.0 model is based on the GREET1-2013 model from Argonne. GREET2014 was released by Argonne on October 3, 2014. ARB should examine GREET2014 to determine improvements that should be made to CA-GREET 2.0. **LCFS 46-116**

<u>Denaturant Modifications for Ethanol</u>

The amount of denaturant assumed in CA-GREET1.8b was 2.0%. However, in CA-GREET-2.0 the amount of non-ethanol material in ethanol was increased to 5.4%. The 5.4% is assumed to be 2.4% denaturant, at most 1 percent water, at most 0.5 percent methanol, and at most 1.4 percent "other." The 2.9% combination of water, methanol, and "other", is assumed to have the same carbon intensity of CARBOB, so the net effect of this assumption is the same as assuming 5.4% CARBOB in ethanol. The CI of CARBOB is higher than most ethanol pathways, so increasing the denaturant from 2% to 5.4% in effect raises the CI of ethanol (and doubles the denaturant effect).

It is very clear that water does not have the CI of CARBOB. It is also highly unlikely that methanol and "other", whatever the other is, would have the same CI as CARBOB. AIR believes increasing the denaturant to 5.4% is a mistake that unfairly **LCFS 46-117**

penalizes ethanol. AIR recommends that the denaturant percentage be set to 2.4% in CA-GREET 2.0.

LCFS 46-117 cont.

DGS Reduced Enteric Emissions Credit

GREET2013 contains a distiller grains (DGs) credit for the coproduct due to reduced enteric fermentation from livestock from feeding with DGs. Staff is proposing no DGs reduced enteric emissions credit "due to the feeding of animals not being considered in the LCFS pathway LCA system boundary." Staff goes on to say that "...including the feeding of animals in the LCA would require significant analysis and would not only include the enteric emissions or change thereof from business as usual, e.g., other emissions would need to be considered and feed markets would need to be analyzed and updated."

Staff's arguments for not including the enteric emissions credit due to feeding of DGs are weak. First, Staff expands the system boundaries in arbitrary ways already. The Staff has included indirect land use system emissions (iLUC), which cannot be measured, and can only be estimated with a combination of economic modeling and estimates of the carbon released during specific land use changes (i.e., the emission factors of each land use change). Staff has spent a great deal of time and effort on this indirect effect. So, other indirect effects such as reduced enteric fermentation should also be included in Staff's analysis. Second, Argonne has already estimated this effect, and has included it in GREET1-2013.

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Staff has no specific criticisms of the effect as estimated in GREET1-2013. Staff say, however, that the primary driver of reduced enteric emissions are shortened lifespan of livestock. Staff is concerned that if feeding DGs increases livestock throughput, then enteric emissions could increase. They also cite studies that show feeding defatted DGs compared to grain feeding causes an increase in N2O emissions from finishing beef cattle, which could reduce the enteric credit.

We recommend that Staff include the DG enteric credit in CA-GREET2.0. It is already included in GREET2013. If Staff have concerns with the effect, then they should develop a better estimate of the effect after finalizing CA-GREET2.0 with the current effect, in much the same way as Staff adopted an iLUC effect in 2009 and have spent some effort in the last 1.5 years attempting to improve it.

We note that there is another very significant effect of enteric fermentation. The economic models show that increasing biofuels requires additional cropland, and much additional cropland comes from pasture and cropland/pasture. This raises livestock prices, thereby reducing total livestock herds and total enteric fermentation emissions. The EPA included this effect in the RFS four years ago. We have repeatedly commented to ARB that the Staff should include this effect as well in its analysis, and Staff has pushed this off to the future. Clearly, there are very significant effects of biofuels on enteric fermentation emissions in two areas – the

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DGs effect and the price effect – and ARB has ignored these effects in this analysis. These are very serious shortcomings in the current ARB analysis.

LCFS 46-119 cont.

Additional Comments by Bruce Dale and Seungdo Kim

Attachment 1 contains additional comments by Ca-GREET2.0 by Kim/Dale. These comments cover a number of items for both corn ethanol and ethanol made from corn stover.

Table 1 summarizes the Kim/Dale comments and their impacts on CaGREET emissions for both corn ethanol and corn stover.

Table 1. Impacts of the Kim/Dale Recommendations on CaGREET Corn Ethanol and Stover Ethanol Emissions		
Corrections	Corn dry mill pathway [gCO_2/MJ]	Corn stover pathway [gCO_2/MJ]
Current fertilizer rates	-0.67	
1.2. CO_2 emissions from limestone	-0.83 ~ -2.18	
1.3. Nutrient contents in fertilizers	-0.06	-0.05
1.5. Soil N_2O emissions from corn stover in corn ethanol	-0.21	
1.6. Supplement nutrients in corn stover ethanol		-7.98
2.2. Lifecycle GHG emissions of sulfuric acid	-0.47	-0.92
2.3. Cellulase enzyme loading in corn stover ethanol		-1.32 ~ -1.79
2.4. Marginal electricity in corn stover ethanol		-8.07
Total	-2.24 ~ -3.59	-26.4~ -26.9

Attachment 1

Review of lifecycle GHG calculations for corn ethanol and corn stover ethanol in the

CA-GREET2.0 model

November 6, 2014

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The authors reviewed farming nutrient emission rates and the emission rates of chemicals used in corn ethanol production in the CA-GREET 2.0 model. We have a number of comments, which are detailed in this document.

The table below summarizes the emission impacts of our comments.

Summary of suggested numerical corrections to the CARB values

Corrections	Corn dry mill pathway [gCO_2/MJ]	Corn wet mill pathway [gCO_2/MJ]	Corn stover pathway [gCO_2/MJ]
1.1. Current fertilizer rates	-0.67	-0.66	
1.2. CO_2 emissions from limestone	-0.83 ~ -2.18	-0.82 ~ -2.14	
1.3. Nutrient contents in fertilizers	-0.06	-0.06	-0.05
1.5. Soil N_2O emissions from corn stover in corn ethanol	-0.21	-0.21	
1.6. Supplement nutrients in corn stover ethanol			-7.98
2.2. Lifecycle GHG emissions of sulfuric acid	-0.47	-0.46	-0.92
2.3. Cellulase enzyme loading in corn stover ethanol			-1.32 ~ -1.79
2.4. Marginal electricity in corn stover ethanol			-8.07
Total	-2.24 ~ -3.59	-2.22 ~ -3.57	-26.4~ -26.9

Our comments are presented in the next two sections. The first section details comments on agricultural chemicals, and the second section deals with chemicals used in corn ethanol plants.

1. Feedstock production (corn grain and corn stover)

1.1. Fertilizer rates in corn grain production

The fertilizer application rates per bushel of corn in the CA-GREET2.0 model (in cells: Inputs!F281:F283) do not reflect the current corn culture practices in the US.

LCFS 46-120

The CA-GREET2.0 supporting document provides a reference[1] for the fertilizer application rates given in the CA-GREET2.0 model. These values are probably based on available data up to 2005. Unfortunately, the timeframe for the fertilizer application rates was not clearly stated in the reference so we are unable to determine how these California values were generated. Furthermore, newer fertilizer application rates for corn culture practices in 2010 are available and should be used in preference to any earlier values. Thus in this report we have used USDA statistics[2] to estimate the US average 2010 fertilizer application rates per bushel of corn—the most recent time period available. These USDA data are summarized in Table 1. The fertilizer rates in the NASS (USDA study) are slightly lower than those in the CA-GREET2.0 model due to higher corn yields. The NASS fertilizer application rates are 4 – 20% less than the rates in the CA-GREET2.0 model.

LCFS 46-120 cont.

Table 1 Fertilizer application rate per bushel of corn produced [2]

	NASS¶	CA-GREET2.0 (in cells: Inputs!F281:F283)
N (gram per bushel)	400.84	415.33
P_2O_5 (gram per bushel)	138.42	147.77
K_2O (gram per bushel)	143.36	172.11

Fertilizer consumption to produce corn silage is excluded from these data.

[1] Wang, Michael Q., Jeongwoo Han, Zia Haq, Wallace E. Tyner, May Wu, and Amgad Elgowainy. "Energy and greenhouse gas emission effects of corn and cellulosic ethanol with technology improvements and land use changes." Biomass and Bioenergy 35, no. 5 (2011): 1885-1896

[2] National Agricultural Statistics Service. http://www.nass.usda.gov/

Using the current fertilizer application rates per bushel of corn from the NASS data summarized in Table 1 reduces the GHG of corn ethanol by 0.67 (0.66) g/MJ in the dry (wet) mill pathway. The detailed calculations are as follows:

The calculations are done in the CA-GREET2.0 spreadsheet model. Replace the fertilizer rates in the CA-GREET2.0 model (in cells: Inputs!F281:F283) by the NASS values in Table 1. Results are summarized in Table 2.

Table 2 Calculations for fertilizer application rates

	Rates from NASS	CA-GREET2.0
GHG associated with fertilizers [gram/MJ] (EtOH!D429)	14.28	14.81
N_2O emissions [gram/MJ] (EtOH!E429)	14.93	15.32
GHG credit of co-products [gram/MJ] (EtOH!G429)	13.21	13.47
GHG of corn ethanol [gram/MJ] (EtOH!Y429)	76.11	76.78

The USDA/NASS statistics[2] also show that fertilizer application rates per bushel (i.e., N, P_2O_5, K_2O applied per bushel of corn produced) have been steadily declining with time. (See Figure 1) Even though total amount of fertilizer applied nationally has increased, the application rate per bushel has actually declined due to higher corn yields. Assuming the trends summarized in Figure 1 have continued, even less total fertilizer use per bushel of corn produced is projected after 2010.

LCFS 46-120 cont.

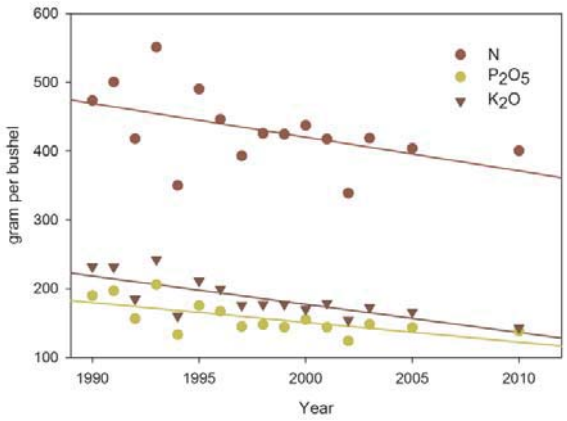


Figure 1 Fertilizer application rates in the US [data source: NASS[2]]

LCFS 46-120 cont.

1.2. CO_2 emissions from limestone

Limestone ($CaCO_3$) is the primary agricultural lime used in the US in 2011[3], accounting for about 93% of the total lime applied. The rest is dolomite ($MgCa(CO_3)_2$). The CA-GREET2.0 model incorrectly assumes that 100% of the carbon in limestone that is applied to soil is released to the air as carbon dioxide and fails to account for various soil, water and atmospheric processes that are very relevant. In contrast, a USDA report[4] based on actual, physical processes occurring in soil, water and the atmosphere finds that two-thirds of the carbon in limestone remains in long-term carbon sinks and only one-third of the carbon in limestone is actually released as carbon dioxide.

LCFS 46-121

[3] United States Environmental Protection Agency (2013) U.S. greenhouse gas inventory report: Inventory of U.S. greenhouse gas emissions and sinks: 1990-2011. United States Environmental Protection Agency, Washington, DC.
[4] USDA (2014) Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory. , Washington, DC.

For example, dissolved CO_2 resulting from root and microbial respiration exists in equilibrium in soil water with H_2CO_3. This slightly acidic H_2CO_3 reacts with limestone[5] as described below in Equations (1) and (2).

$$CO_2 + H_2O \rightarrow H_2CO_3 \quad (1)$$

$$CaCO_3 + H_2CO_3 \rightarrow Ca^{2+} + 2HCO_3^- \quad (2)$$

Dissolved HCO_3^- is stable and is transported to the ocean by rivers and streams. In the ocean, this carbon is sequestered for time periods of decades to centuries[4].

In a separate study, West and McBride[6] also estimate the carbon dioxide emission factors for limestone applied by accounting for leaching and transport by rivers to the ocean. The carbon dioxide emission factors for limestone applied to agricultural land given in their study are 0.059 kg C/kg limestone applied for limestone and 0.064 kg C/kg dolomite applied for dolomite. These are the emission values currently used in the U.S. National GHG Inventory[3]. However, they do not include the entire range of biophysical processes covered by the USDA report[4].

CA-GREET2.0 should use the most comprehensive, scientifically-valid calculations available to estimate the GHG emissions of agricultural lime application. We believe

LCFS 46-121 cont.

[5] Hamilton, Stephen K., et al. "Evidence for carbon sequestration by agricultural liming." Global Biogeochemical Cycles 21: 1 - 12 (2007).
[6] West TO, McBride AC (2005) The contribution of agricultural lime to carbon dioxide emissions in the United States: dissolution, transport, and net emissions. Agr Ecosyst Environ 108:145–154

those are the values given by the USDA report[4]. The carbon dioxide emission factors for agricultural limestone applied are summarized in Table 3 below.

Table 3 Carbon dioxide emission factors for agricultural limestone application

	Carbon dioxide emission from Limestone [kg CO_2/kg]
CA-GREET2.0	0.44
USDA[4]	-0.15
GREET2014[7] & West and McBride[6]	0.216

Using the carbon dioxide emission factors from the USDA process-based report[4] and the GREET2014 model[7] reduces the GHG of corn ethanol by 0.83 and 2.18 (0.82 and 2.14) g/MJ in the dry (wet) mill pathway, respectively. The detailed calculations are as follows:

Replace the carbon dioxide emission factors in the CA-GREET2.0 model (in cells: EtOH!F380, 44/100) by the factors in Table 3. Results are summarized in Table 4.

Table 4 Calculations for lime application

	Factor from USDA report[4]	Factor from GREET2014[7]	CA-GREET2.0
CO_2 from $CaCO_3$ use [gram/bushel] (EtOH!F380)	-169	249	506

LCFS 46-121 cont.

[7] Argonne National Laboratory (2014) Greenhouse gases, regulated emissions, and energy use in transportation (GREET) computer model 2014.

GHG associated with fertilizers [gram/MJ] (EtOH!D429)	11.81	13.66	14.81
GHG credit of co-products [gram/MJ] (EtOH!G429)	12.66	13.16	13.47
GHG of corn ethanol [gram/MJ] (EtOH!Y429)	74.60	75.94	76.78

LCFS 46-121 cont.

1.3. Nutrient contents in N and P_2O_5 fertilizers

LCFS 46-122

The CA-GREET2.0 model assumes that N fertilizer consists of ammonia, urea, ammonium nitrate, urea-ammonium nitrate solution, mono-ammonium phosphate, and di-ammonium phosphate, and P fertilizer consists of mono-ammonium phosphate, and di-ammonium phosphate as summarized in Table 5. However, the nutrient contents in some of these fertilizers are not given correctly in the CA-GREET2.0 model. The nitrogen content in di-ammonium phosphates is 18%[8], not 16% as given in the CA-GREET2.0 model. The P_2O_5 contents in mono- and di-ammonium phosphates are 48 -61% (the most common value is 52%) and 46%[8], respectively.

Table 5 Fraction and nutrient content of N and P_2O_5 fertilizers in CA-GREET2.0 [basis: N for N fertilizer, P_2O_5 for P fertilizer]

N fertilizer	Ammonia	Urea	Ammonium Nitrate	Urea-Ammonium Nitrate Solution	Mono-ammonium Phosphate	Di-ammonium Phosphate
Fraction	0.31	0.23	0.04	0.32	0.04	0.06
N content (%)	82.4%	46.7%	35.0%	-	11.0%	16.0% (Ag_Inputs!AC74)

[8] Penn State Extension, Nitrogen Fertilizers. http://extension.psu.edu/agronomy-guide/cm/tables/table-1-2-11

P_2O_5 fertilizer		Mono-ammonium Phosphate	Di-ammonium Phosphate
Fraction		0.5	0.5
P_2O_5 content (%)		48.0% (Ag_Inputs!AE74)	48.0% (Ag_Inputs!AF74)

Using the correct nutrient contents reduces the GHG of corn ethanol by 0.06 (0.06) g/MJ in the dry (wet) mill pathway and reduces the GHG of corn stover ethanol by 0.05 g/MJ. The detailed calculations are as follows:

Replace the nutrient content in the CA-GREET2.0 model (in cells: Ag_Inputs!AC74, Ag_Inputs!AE74, Ag_Inputs!AF74) by the corrected values (18% for Ag_Inputs!AC74; 52% for Ag_Inputs!AE74; 46% for Ag_Inputs!AF74). Results are summarized in Table 6.

LCFS 46-122 cont.

Table 6 Calculations for nutrient content

	Corrected values	CA-GREET2.0
Corn ethanol in the dry mill pathway		
GHG associated with fertilizers [gram/MJ] (EtOH!D429)	14.72	14.81
N_2O emissions [gram/MJ] (EtOH!E429)	15.32	15.32
GHG credit of co-products [gram/MJ] (EtOH!G429)	13.44	13.47
GHG of corn ethanol [gram/MJ] (EtOH!Y429)	76.72	76.78
Corn stover ethanol		

GHG associated with fertilizers¶ [gram/MJ]	10.06	10.11
GHG of corn stover ethanol§ [gram/MJ]	14.63	14.68

¶ Sum of GHG from cells EtOH!CJ371:EtOH!CN379 divided by ethanol yield (EtOH!G141) and converted to MJ
§ Sum of cells EtOH!AG412:AH412

LCFS 46-122 cont.

1.4. Emissions of N and P_2O_5 fertilizers

Mono- and di-ammonium phosphate fertilizers contain both N and P_2O_5 nutrients. Therefore, the CA-GREET2.0 model probably uses allocation factors to assign emissions to either N or P_2O_5. However, there is no background information given in the CA-GREET2.0 model to describe and define how these putative allocation factors were chosen. The choice of allocation factors should be transparent and readily available through the CA-GREET2.0 model.

The amounts of N and P_2O_5 fertilizers applied based on the fractions of each fertilizer used in agriculture and their respective nutrient contents as given by CA-GREET2.0 are not equal to those of N and P_2O_5 fertilizers used in corn grain production as seen in Table 7. Emissions of N and P_2O_5 fertilizers (in cells: EtOH!D365:E379) are associated with using 439.8 g of N fertilizer and 284.2 g of P_2O_5 fertilizer, not 415.33 g of N fertilizer and 147.77 g of P_2O_5 fertilizer. Therefore, emissions of N and P_2O_5 fertilizers (in cells: EtOH!D365:E379) do not represent emissions associated with the actual amounts of N (415.33 gram/bushel) and P_2O_5

LCFS 46-123

(147.77 gram/bushel) used in corn grain production and should be recalculated to be consistent with current actual corn grain production practice.

LCFS 46-123 cont.

Table 7 Quantities of N and P_2O_5 fertilizers in CA-GREET2.0 [basis: N for N fertilizer, P_2O_5 for P_2O_5 fertilizer]

	N fertilizer		P_2O_5 fertilizer	
	Nutrient [gram/bushel]			
	N	P_2O_5	N	P_2O_5
Ammonia	124.3			
Urea	92.2			
Ammonium Nitrate	16.0			
Urea-Ammonium Nitrate Solution	128.3			
Mono-ammonium Phosphate	16.0	70.0	15.9	69.2
Di-ammonium Phosphate	24.1	72.2	23.1	69.2
Sum	400.8	142.1	38.9	138.4
Total N	400.8 + 38.9 = 439.8			
Total P_2O_5	142.1 + 138.4 =284.2			

1.5. Soil N_2O emissions from corn stover due to corn ethanol production

LCFS 46-124

The CA-GREET2.0 model uses the emission factor (1.325%) for N_2O according to the IPCC guidelines[9], which include direct and indirect N_2O emissions. The CA-GREET2.0 model applies this emission factor to both inorganic fertilizer and corn stover. However, the IPCC guideline[9]

does not include volatile nitrogen loss from crop residues. This volatile nitrogen is lost to the air and is thus not available for soil microbes to convert it to N_2O. Thus, the N_2O emission factor for corn stover should be reduced to 1.225%. The data surrounding this correction to the CA-GREET2.0 calculations are summarized in Table 8. Box 1 below quotes the relevant procedures for calculating indirect N_2O emissions as given in the IPCC guideline[9].

LCFS 46-124 cont.

Table 8 Emission factor

	IPCC[9]	CA-GREET2.0
Fertilizer		
Direct N_2O from fertilizer	0.01	0.01
Indirect N_2O from volatized N from fertilizer	0.001 (=0.1*0.01)	0.001 (=0.1*0.01)
Indirect N_2O from leached N from fertilizer	0.00225 (=0.3*0.075)	0.00225 (=0.3*0.075)
Emission factor for fertilizer	0.01325	0.01325
Crop residues		

[9] Intergovernmental Panel on Climate Change (2006) 2006 IPCC guidelines for national greenhouse gas inventories. http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

Direct N_2O from crop residues	0.01	0.01
Indirect N_2O from volatized N from crop residues	-	0.001 (=0.1*0.01)
Indirect N_2O from leached N from crop residues	0.00225 (=0.3*0.075)	0.00225 (=0.3*0.075)
Emission factor for crop residues	0.01225	0.01325

Box 1. Indirect N_2O calculations (quoted from the IPCC guideline[9])

Volatilization, $N_2O(ATD)$

N_2O FROM ATMOSPHERIC DEPOSITION OF N VOLATILISED FROM MANAGED SOILS (TIER 1)

$$N_2O(ATD)\text{–}N = [(FSN \bullet FracGASF) + ((FON + FPRP) \bullet FracGASM)] \bullet EF4$$

Where:

$N_2O(ATD)$–N = annual amount of N_2O–N produced from atmospheric deposition of N volatilized from managed soils, kg N_2O–N yr^{-1}

FSN = annual amount of synthetic fertilizer N applied to soils, kg N yr^{-1}

FracGASF = fraction of synthetic fertilizer N that volatilizes as NH_3 and NOx, kg N volatilized (kg of N applied) $^{-1}$

FON = annual amount of managed animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}

FPRP = annual amount of urine and dung N deposited by grazing animals on pasture, range and paddock, kg N yr^{-1}

LCFS 46-124 cont.

FracGASM = fraction of applied organic N fertilizer materials (FON) and of urine and dung N deposited by grazing animals (FPRP) that volatilizes as NH_3 and NOx, kg N volatilized (kg of N applied or deposited) $^{-1}$)
EF4 = emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces,
[kg N– N_2O (kg NH_3–N + NOx–N volatilized) $^{-1}$]

This correction reduces the GHG of corn ethanol by 0.21 (0.21) g/MJ in the dry (wet) mill pathway. The detailed calculations are as follows:

Replace the emission factor for corn stover in the CA-GREET2.0 model (in cells: EtOH!D382) by the IPCC emission factor given in Table 8 above. Results are summarized in Table 9.

LCFS 46-124 cont.

Table 9 Calculations for nutrient content

	IPCC value	CA-GREET2.0
Corn ethanol in the dry mill pathway		
N2O from nitrogen fertilizer, and above and below ground biomass [gram/bushel] (EtOH!D382)	11.374	11.596
N_2O emissions [gram/MJ] (EtOH!E429)	15.03	15.32
GHG credit of co-products [gram/MJ] (EtOH!G429)	13.39	13.47
GHG of corn ethanol [gram/MJ] (EtOH!Y429)	76.56	76.78

1.6. Supplemental nutrients in corn stover ethanol production

LCFS 46-125

In the CA-GREET2.0 model, supplemental nutrients (i.e., N, P_2O_5, K_2O) are added in the subsequent growing season to replace nutrients that are assumed to be lost when corn stover is collected to produce corn ethanol. The amount of the supplement nutrients required is assumed to be exactly equal to the nutrient content of the corn stover removed. However, the supplemental nutrients required depend on actual crop management practices used in the subsequent growing season. According to USDA statistics[10], only 33% of cornfields function as cornfields ("corn on corn") in the subsequent growing season, while about 48% of cornfields are used to grow soybeans in the subsequent growing season. Approximately 2.4% of cornfields are converted to developed land, open water or left fallow in the subsequent growing season. This information is summarized in Figure 2.

Supplemental N nutrients in the following growing season are therefore not necessary for croplands used to produce soybeans even though the nitrogen content in corn stover was removed. Furthermore, supplemental nutrients are not necessary for lands converted to developed land, open water or left fallow. Therefore, supplemental N nutrients are needed in only 49% (=100% - 48% (soybean) - 2.4% (fallow, etc.)) of corn-producing croplands next year, and the supplemental P and K nutrients are needed in only 98 % (100% – 2.4% (fallow, etc.)) of croplands from cornfields next year. By accounting properly for the actual use of corn land in the subsequent growing season, the GHG of corn stover ethanol is reduced by 7.98 g/MJ. The detailed calculations are as follows:

LCFS 46-125 cont.

[10] USDA, CropScape - Cropland Data Layer. http://nassgeodata.gmu.edu/CropScape/

Multiply the fertilizer used in the CA-GREET2.0 model (in cells: EtOH!H20:H22) by 0.49 for N, and 0.98 for P_2O_5 and K_2O, respectively. Results are summarized in Table 10 below.

LCFS 46-125 cont.

Table 10 Calculations for supplemental nutrients required for continuous corn

	Corrected values	CA-GREET2.0
GHG associated with fertilizers¶ [gram/MJ]	6.01	10.11
N2O from nitrogen fertilizerΓ [gram/MJ]	-3.87	0
GHG of corn stover ethanol§ [gram/MJ]	6.71	14.68

¶ Sum of GHG from cells EtOH!CJ371:CN379 divided by ethanol yield (EtOH!G141) and converted to MJ
Γ cells EtOH!CJ382 converted to MJ
§ Sum of cells EtOH!AG412:AH412

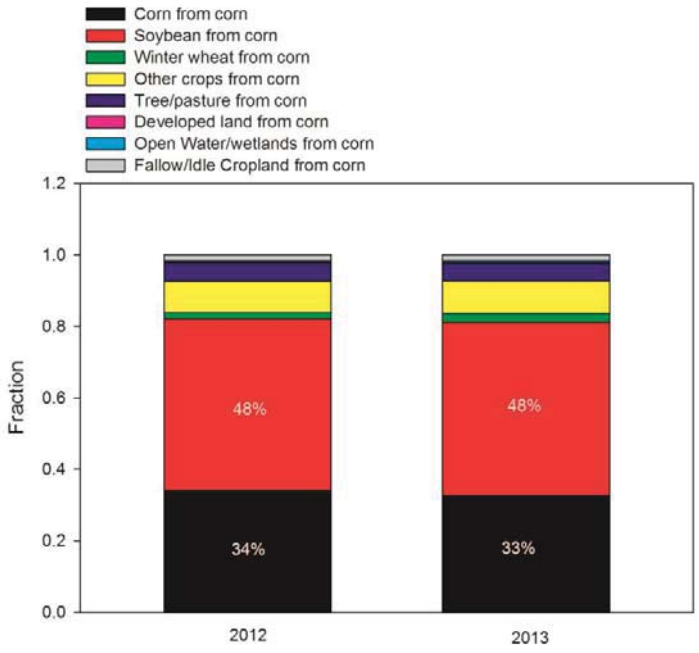


Figure 2 Land use changes in corn cultivation [data source: USDA[10]]

2. Ethanol production (dry mill and cellulosic biorefinery)

2.1. CO_2 emissions from urea displaced by DDGS

LCFS 46-126

Enzymes from bacteria in cattle rumen, specifically urease, break down urea to CO_2 and ammonia, and CO_2 is released. Displacing urea by DDGS avoids those CO_2 emissions. However, the CA-GREET2.0 does not include a credit for CO_2 emissions from urea displaced by DDGS. Even though this value is very small, it should be included in the model for completeness.

2.2. Lifecycle GHG emissions of sulfuric acid in corn stover ethanol

LCFS 46-127

About 250 grams of sulfuric acid (EtOH!CR361) are used to produce one gallon of corn stover ethanol. A plant producing sulfuric acid generally exports thermal energy (steam) and electricity, and therefore its net energy use is negative[11, 12]. However, the CA-GREET2.0 model does not include the correct energy credits for the exported energy in calculating lifecycle emissions of sulfuric acid. Assuming that 2.1 MMBTU per ton of sulfuric acid[11] is exported from a sulfuric acid plant, the GHG of corn ethanol is reduced by 0.47 (0.46) g/MJ in the dry (wet) mill pathway, and the GHG of corn stover ethanol is reduced by 0.92 g/MJ. The detailed calculations are as follows:

Add an energy credit (2.1 MMBTU/ton) in the cell Ag_Inputs!R26 in the CA-GREET2.0 model. Results are summarized in Table 11. In the CA-GREET2.0 model, sulfuric acid is used to manufacture the phosphorus-containing fertilizers.

The lifecycle GHG of sulfuric acid also affects lifecycle GHG of mono- and di-ammonium phosphates. Correcting the lifecycle GHG of sulfuric acid also changes the GHG of corn ethanol.

LCFS 46-127 cont.

Table 11 Calculations for sulfuric acid

	Corrected values	CA-GREET2.0
Corn ethanol in the dry mill pathway		
GHG associated with fertilizers [gram/MJ] (EtOH!D429)	14.16	14.81

[11] USDOE, Energy and Environmental Profile of the U.S. Chemical Industry, 2000.
[12] National Renewable Energy Laboratory. U.S. Life Cycle Inventory Database.

GHG credit of co-products [gram/MJ] (EtOH!G429)	13.29	13.47
GHG of corn ethanol [gram/MJ] (EtOH!Y429)	76.30	76.78
Corn stover ethanol		
GHG associated with fertilizers¶ [gram/MJ]	9.73	10.11
GHG of biorefineryΓ [gram/MJ]	13.65	14.19
GHG of corn stover ethanol§ [gram/MJ]	13.76	14.68

¶ Sum of GHG from cells EtOH!CJ371:CN379 divided by ethanol yield (EtOH!G141) and converted to MJ
Γ Sum of GHG from cells EtOH!CR371:CR380
§ Sum of cells EtOH!AG412:AH412

LCFS 46-127 cont.

2.3. Cellulase enzyme loading in corn stover ethanol

Recent authoritative studies[13, 14] show that current cellulase enzyme loadings range from 17.5 - 19.9 mg per g of cellulose for dilute acid pretreatment of corn stover followed by enzymatic hydrolysis and fermentation of the sugars to ethanol. This enzyme application rate is equivalent to about 72 – 83 g enzyme per gallon of

LCFS 46-128

[13] Humbird D, Davis R, Tao L, Kinchin C, Hsu D, Aden A, Schoen P et al. Process design and economics for biochemical conversion of lignocellulosic biomass to ethanol: Dilute-acid pretreatment and enzymatic hydrolysis of corn stover. Colorado: National Renewable Energy Laboratory; 2011.
[14] da Costa Sousa L, Jin M, Uppugundla M, Bokade V, Humpula JF, Gunawan C, Foston MB et al. Extractive AFEX™ (E-AFEX™) pretreatment: a unified approach for resolving bottlenecks to efficient cellulosic bioethanol production. New Orleans, LA: 34th Symposium on Biotechnology for Fuels and Chemicals; 2012.

ethanol. However, the enzyme loading used the CA-GREET2.0 model (cells EtOH!CR359) is 113.4 g per gallon of ethanol, which is higher than the current enzyme technologies actually require. Applying current enzyme technologies as summarized in the 2011 National Renewable Energy Laboratory study reduces emissions by 1.32 – 1.79 g/MJ. The detailed calculations are as follows:

Replace the enzyme loading rate in the CA-GREET2.0 model (cells EtOH!CR359) by new enzyme loading values. Results are summarized in Table 12.

LCFS 46-128 cont.

Table 12 Calculations for enzyme loading

	Current technologies		CA-GREET2.0
Enzyme loading [g per gallon]	72	83	113.4
Ethanol yield [gallon/dry ton]	70	79	80
GHG of biorefineryΓ [gram/MJ]	12.39	12.87	14.19
GHG of corn stover ethanol§ [gram/MJ]	12.89	13.37	14.68

Γ Sum of GHG from cells EtOH!CR371:CR380
§ Sum of cells EtOH!AG412:AH412

2.4. Marginal electricity in corn stover ethanol

LCFS 46-129

The CA-GREET2.0 model assumes that excess electricity from a cellulosic biorefinery displaces US average electricity demand. However, it is more reasonable to assume that excess electricity would displace marginal electricity, not US average electricity, which consists of electricity from many different energy sources (i.e.,

fossil fuel, nuclear, renewable energy sources, and hydro). Excess electricity from a cellulosic biorefinery will likely displace electricity from a coal or natural gas-fired power plant, not electricity from nuclear power plant. A nuclear power plant must keep its electricity production level constant at all times. In contrast, marginal electricity is electricity from a power plant which can be brought on line quickly so that the power plant can respond to changing demand for electricity. Nuclear plants and hydroelectric stations are thus ruled out as suppliers of marginal electricity—they can only satisfy base load electricity demand. Electricity from renewable energy sources such as wind and solar are also excluded as sources of marginal electricity because of renewable energy certificates.

Therefore, the marginal electricity replaced by excess electricity from a cellulosic biorefinery would be marginal electricity derived from burning fossil fuels (i.e., coal, petroleum, natural gas). The fuel mix used for marginal electricity production is 64% coal, 34% natural gas and 2% petroleum. These percentages are based on electricity fuel mixes given in the CA-GREET2.0 model. When marginal electricity generated from these fossil fuels is displaced by excess electricity from a cellulosic biorefinery, the GHG of corn stover ethanol is reduced by 8.07 g/MJ. The detailed calculations are as follows:

Create new sheet for marginal electricity in the CA-GREET2.0 model. The new sheet is named “marginal elec”. Replace the electricity fuel mixes in the cells (marginal elec!C56:C72) by marginal fuel mixes - coal (64%), natural gas (34%), petroleum

LCFS 46-129 cont.

(2%), others (0). Replace emissions associated with electricity (EtOH!CS371:CS379) by emissions of marginal electricity. Results are summarized in Table 13.

LCFS 46-129 cont.

Table 13 Calculations for marginal electricity

	Marginal electricity	CA-GREET2.0
GHG creditΓ [gram/MJ]	-27.54	-19.47
GHG of corn stover ethanol§ [gram/MJ]	6.62	14.68

Γ GHG from cells EtOH!CS371:CS379 and converted to MJ
§ Sum of cells EtOH!AG412:AH412

17_OP_ADF_GE Responses (Page 91 – 117)

101. Comment: **LCFS 46-115 through LCFS 46-129**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

Appendix C

REVIEW OF THE SUGAR CANE ETHANOL PATHWAYS IN CA-GREET 2.0

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EXECUTIVE SUMMARY

The California Air Resources Board (Board/ARB) is proposing to re-adopt the Low Carbon Fuel Standard (LCFS) regulation and to include updates and revisions compared to the previous regulation. The ARB staff will bring a new LCFS regulation to the Board for consideration in February 2015. The proposed LCFS regulation will contain revisions to the 2010 LCFS as well as new provisions designed to foster investments in the production of the low-CI fuels, offer additional flexibility to regulated parties, update critical technical information, simplify and streamline program operations, and enhance enforcement.

To address these issues with fuel pathway certifications, staff is proposing a two-tiered system in which conventionally produced first-generation fuels, such as starch- and sugar-based ethanol, would fall into the first tier. Next-generation fuels, such as cellulosic alcohols, would fall into the second tier.

ARB has stated that the Tier 1 process simplifies and expedites the certification process by providing applicants with a streamlined CI calculator that computes pathway CIs using a base set of input parameters needed to determine a Tier 1 pathway CI. This method will use the CA-GREET 2.0 model. This model is a California version of the GREET1 2013 model.

Scope of Work

This work reviews the sugarcane ethanol pathways in the new CA GREET model to ensure that they function properly and utilize the best available science. The review has considered the following questions.

Are the pathways consistent?

It is important that the model uses the same basic approach, including system boundaries and assumptions for all of the ethanol pathways and ideally all of the fuel pathways.

Does the model ask for the key input parameters?

The model will use a combination of default values and user defined inputs to model specific plants. It will be important that all of the important parameters that change from one plant configuration to another are user defined inputs and are not default values.

Does the model reflect the actual practices?

The model must include all of the actual steps in the production process for it to be useful. If it doesn't, some plants will not be able to generate accurate values.

Does the model have the correct background data and are the calculations correct?

Finally it is important that the model contains the best available background data and that the model functions properly. Background data would include the default values, biomass and fuel characteristics, and other inputs.

A significant number of issues were identified. Most of the issues results in the model returning values that are lower than what would be returned if the issues were addressed properly.

Sugar Cane Farming Summary

The CA GREET model does not apply different energy use factors to sugar cane farming even though the two scenarios with mechanical harvesting require almost twice the energy of a manual harvest system. A mechanical harvest system with 100% of the energy supplied by diesel fuel will have GHG emissions of 7.54 g CO_2eq/MJ.

There is evidence that the crop residues that are left on the field are reducing the synthetic nitrogen that is required. The proportion of nitrogen from fertilizer and from crop residue should vary depending on whether or not there is straw burning. The CA GREET model is assuming that there is no difference in nitrogen requirements between burned and unburned fields, an unlikely scenario.

Although there is significant uncertainty regarding the appropriate N_2O emission factor for sugar cane production, the best information in the peer reviewed literature would suggest that the 1% EF1 factor used by CARB is too low. The impact of increasing this to 1.5% is an increase in sugar cane N_2O emissions of 2.83 g CO_2eq/MJ.

Straw Burning Summary

The straw burning emissions appear to be too low by about 4.42 g CO_2eq/MJ as a result of using the IPCC emission factors for Ag residue burning rather than the values for grassland and savanna burning. This increase would be reduced to about 2.5 g CO_2eq/MJ if the nitrogen from the burned straw was not returned to the soil as discussed in the previous section.

Cane Transport Summary

The model should be changed so that the share of the delivery of cane by medium duty trucks and by heavy duty trucks is a user input. The truck energy requirements are the same as for corn ethanol.

Ethanol Production Summary

There are several errors in the CA GREET model related to the transfer of information from the T1 Calculator sheet to the core of the model. These include:

1. Nuclear and biomass power shares of the power generation are transposed when they are transferred to the ETOH sheet.
2. The inputs for sulphuric acid and ammonia are input into the cells for enzymes when they move from the T1 Calculator sheet to the ETOH sheet. Entering non-zero values will produce extremely high and erroneous GHG emissions.

There is also the potential for misinterpretation of the input values. The input for Residual oil is really the quantity of used lubricants that are burned in the plant and not the input of residual oil.

The quantity of biomass that is burned at the plants is hard coded in the model. Not all mills burn all of the bagasse on site; some sell a portion to other local industries. The emissions for these operations will be overestimated. The biomass from the T1 Calculator sheet is transferred to the ETOH sheet, but once it goes there it is not included in any calculations. A proper modelling would require the mills to enter the bagasse consumed and not hard code those quantities. The current model would underestimate the emissions from mills that imported bagasse from another facility or used some straw from the fields to produce more electric power for export.

Transportation Summary

There are issues with the ocean shipping calculations in GREET for many of the fuels, including sugarcane ethanol. The issues for sugar cane ethanol include:

1. The shipment size of 22,000 tons is too high and is not a user input.
2. Ethanol, uniquely of all of the fuels in CA GREET, is not charged with a backhaul.
3. The energy use for ocean shipping is calculated but the calculations underestimate the energy used by a significant amount.
4. Energy use in the model is 145 BTU/ton-mile. Data from the IMO suggests that this should be 335 BTU/ton-mile plus 283 BTU/ton-mile for the backhaul. This would increase the ocean shipping emissions by 17.0 g CO_2eq/MJ, a very significant difference.

Summary

With respect to the four questions that were investigated we find that:

1. There are inconsistencies between some aspects of the sugarcane ethanol pathway and all other pathways.
2. There are key input parameters that should be specified by the user of the model. These would include; the share of cane transported by MD and HD trucks, the ocean shipment size, and confirming that a backhaul is always provided.
3. The model does not reflect actual practice. The lack of change in the farming emissions with the different practices that are employed is problematic. The ocean shipping size is double the typical shipments.
4. The background data in the model is not accurate. Although the biggest issue is with the energy used for ocean shipping, the emission factor applied to cane burning should also be changed.

In addition, there are some programming errors in the calculator that need to be adjusted. The following two tables itemize the changes that should be made to the model.

Table ES- 1 Summary of Changes - Farming

Stage	Manual Harvest			Mechanical Harvest		
	Default	Revised	Change	Default	Revised	Change
All Diesel	4.65	5.39	0.74	4.65	5.39	0.74
Extra Diesel for Mech Harvest					7.54	2.15
Extra N Fert for manual	3.22	4.43	1.21			
N_2O from extra N	2.88	3.96	1.08			
Total			3.03			2.89

Table ES- 2 Changes to Rest of Pathway

Item	Default	Revised	Change
N_2O EF	7.48	10.31	2.83
Residue Leaching		7.13	-0.35
Straw Burning EF	10.06	14.42	4.36
Power Export	-0.72	-0.76	-0.04
Shipping			
Backhaul (default value)	7.16	11.41	4.25
Ship size (default value)		18.88	7.47
Int'l Marine Org. Energy		24.15	5.27
Total			23.79

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1. INTRODUCTION

The California Air Resources Board (Board/ARB) is proposing to re-adopt the Low Carbon Fuel Standard (LCFS) regulation and to include updates and revisions compared to the previous regulation. The ARB staff will bring a new LCFS regulation to the Board for consideration in February 2015. The proposed LCFS regulation will contain revisions to the 2010 LCFS as well as new provisions that the staff claims are designed to foster investments in the production of the low-CI fuels, to offer additional flexibility to regulated parties, to update critical technical information, and to simplify and streamline program operations, and enhance enforcement.

Based on stakeholder comments received in both the original 2009 rulemaking and the 2011 amendments, the Board directed staff in Resolutions 09-31 and 11-39 to consider revisions to the regulation in a number of specific areas, including the approval of additional fuel pathways. Additionally, staff has indicated that it has conducted internal reviews of lessons learned and has been assessing what has changed since the initial implementation of the LCFS. It is evident that evaluating fuel pathways is very resource-intensive.

Furthermore, stakeholders have expressed concerns that many of the Method 2 pathways in the Lookup Table and on the Method 2 web site are not available for wider use by regulated parties.

In order to attempt to address these issues with fuel pathway certifications, staff is proposing a two-tiered system in which conventionally produced first-generation fuels, such as starch- and sugar-based ethanol, would fall into the first tier. Next-generation fuels, such as cellulosic alcohols, would fall into the second tier.

The ARB staff has stated that the Tier 1 process simplifies and expedites the certification process by providing applicants with a streamlined CI calculator that computes pathway CIs using a base set of input parameters needed to determine a Tier 1 pathway CI. This method will use the CA-GREET 2.0 model. This model is a California version of the GREET1 2013 model.

1.1 SCOPE OF WORK

This work reviews the sugarcane ethanol pathways in the new CA GREET model to ensure that they function properly and utilize the best available science. The review has considered the following questions.

Are the pathways consistent?

It is important that the model uses the same basic approach, including system boundaries and assumptions for all of the ethanol pathways and ideally all of the fuel pathways.

Does the model ask for the key input parameters?

The model will use a combination of default values and user defined inputs to model specific plants. It will be important that all of the important parameters that change from one plant configuration to another are user defined inputs and are not default values.

Does the model reflect the actual practices?

The model must include all of the actual steps in the production process for it to be useful. If it doesn't, some plants will not be able to generate accurate values.

Does the model have the correct background data and are the calculations correct?

Finally it is important that the model contains the best available background data and that the model functions properly. Background data would include the default values, biomass and fuel characteristics, and other inputs.

The report follows the structure of the model. The following sections consider the sugarcane farming operations, straw burning, can transportation, ethanol production, and ethanol transport from Brazil to California.

The model contains four basic sugarcane ethanol pathways:

- Sugarcane Ethanol – Base Case
- Sugarcane Ethanol – with Power Export
- Sugarcane Ethanol – Mechanized Harvest
- Sugarcane Ethanol – Mechanized Harvest with Power Export.

The values that are on the T1 Calculator sheet in the user input cells are not necessarily the expected user values for those cells so there are no default values per se for the four pathways. The direct CI values in the following table are therefore indicative of differences between the four pathways. These do not include the denaturant and the ILUC values.

Table 1-1 Sugarcane Ethanol Indicative CI Values

	Base Case	Power Export	Mechanized Harvest	Mechanized Harvest with Power Export
	g CO_2eq/MJ			
Farming energy	4.65	4.65	4.65	4.65
Fertilizers	4.67	4.67	4.67	4.67
N_2O in Soil	7.48	7.48	7.48	7.48
Straw Burning	10.06	10.06	10.06	10.06
Cane Transportation	1.29	1.29	1.29	1.29
Mechanized Harvesting Credit	0.00	0.00	-10.06	-10.06
Filter Cake T&D	0.01	0.01	0.01	0.01
Plant Energy	2.30	2.30	2.30	2.30
Ethanol T&D	7.16	7.16	7.16	7.16
Power Credit	0.00	-0.72	0.00	-0.72
Total	37.62	36.90	27.56	26.84

Not all sugarcane plants will be able to use the calculator as their operations do not fit the four cases. These include fields that are burned and mechanically harvested and mechanically harvested fields that collect some of the residue to supplement the bagasse for power generation. These kinds of plants will have to follow a Tier 2 method.

CARB have also been allowing some plants that produce sugar and ethanol to reduce the sugarcane production emissions through the use of economic allocation between the sugar and the molasses that is used for the ethanol feedstock. The calculator could not be used for those plants. Economic allocation is the least preferred approach under ISO LCA guidelines. The plants that co-produce sugar and ethanol should have the available

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data on energy use in distillation and in crystallization to be able to undertake the CI calculation without any allocation.

LCFS 46-130 cont.

2. SUGAR CANE FARMING

The CA GREET model has no user inputs for farming energy, fertilizer, and N_2O emissions. Nor do these values change with the two process modifiers (mechanical harvest and power credit). This is consistent with the other biofuel pathways, where feedstock production values are fixed by the model, but there is a difference in mechanical vs. manual harvest in terms of the fuel energy used and some other parameters.

2.1 ENERGY

Farming energy in the model is supplied by diesel, LPG, gasoline, natural gas, electricity, and renewable natural gas. The default values and their contribution are summarized in the following table. While one can change the default values, they don't go anywhere in the model. The small amount of natural gas on the T1 Calculator sheet is not included in the model.

Table 2-1 Farming Energy

Fuel	Value, BTU/tonne	GHG emissions, g CO_2eq/MJ
Diesel Fuel	36,385	2.061
Gasoline	11,685	0.654
Natural Gas	20,425	0.954
LPG	17,860	0.881
Electricity	8,550	0.092
Renewable Natural gas	95	0.000
Total	95,000	4.642

The sources for the energy use in farming report the energy consumption as diesel fuel per tonne of cane, so it is not clear where the breakdown of fuel use by fuel type came from. If all of the fuel was diesel fuel, then the emissions would increase to 5.39 g CO_2eq/MJ (an increase of 0.75 CO_2eq/MJ).

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The 95,000 BTU/tonne was introduced in GREET1 2011 and was about twice as high as the previous value, which used data from 2002. It was suggested by Dunn et al (2011) that the reason for the increase could be due to the increase in mechanical harvesting. A recent paper by Wang et al (2014) considered changes in the Brazilian sugarcane industry between 2010 and 2020. The diesel fuel parameters used in that study are shown in the following table.

Table 2-2 Sugar Cane Farming Parameters

	2010	2015	2020
Yield, tonnes/ha	70.5	80.0	84.0
Mechanical Harvest rate, %	50	80	100
Diesel Fuel consumption, l/ha	230	280	314
Diesel, l/tonne	3.26	3.50	3.92
Diesel, BTU/tonne	110,600	118,800	133,000

The energy use is all higher than is found in CA GREET. This data indicate that the farming energy for manual harvesting should be about 2.4 l/tonne (81,000 BTU/tonne) and for 100% mechanical harvest it should be at least 3.9 l/tonne (133,000 BTU/tonne)

and not the same for both cases. This difference in farming energy should be very simple to implement in the CA GREET model.

LCFS 46-131 cont.

2.2 FERTILIZERS

The fertilizer parameters are also set in CA GREET and are not to be adjusted by users. The default values and their impact on the GHG emissions from the manufacturing of the fertilizers are shown in the following table. The values on the T1 Calculator tab do not leave the sheet.

Table 2-3 Fertilizer Parameters

Component	Input	GHG Emissions, g CO2eq/MJ
Nitrogen, g/tonne	800.00	3.22
P_2O_5, g/tonne	300.00	0.11
K_2O, g/tonne	1,000.00	0.21
$CaCO_3$, g/tonne	5,200.00	0.71
Herbicide, g/tonne	45.00	0.39
Insecticide, g/tonne	2.50	0.02
Total		4.66

LCFS 46-132

There is a range of fertilizer rates that can be found in the literature. The values used in GREET are within the range and are generally weighted to the more recent data such as the Seabra et al. 2011 report. It is obviously the nitrogen rate that has the largest impact and the earlier version of GREET, such as 1.8d used 1091.7 g/tonne of cane.

It is likely that one of the reasons for a trend to lower nitrogen inputs is the increase in mechanical harvesting and the elimination of the straw burning. This increases the nitrogen in the crop residues that are returned to the soil. The nitrogen content of the residues that are not burned during a mechanical harvest were estimated by Fortes et al (2013) to be 41 kg/ha, or 512 g/tonne at an 80 tonne/ha yield. This is consistent with the reduction N fertilizer seen over the past decade and the reduction in straw burning that accompanies the increase in mechanical harvesting.

The conclusion is that, like the farm energy, it is not appropriate to use the same fertilizer parameters for all four scenarios. There should be different parameters for the manual harvest from the mechanized harvest. The manual harvest should have higher nitrogen inputs than the average values in the model and the mechanized harvest should be lower than the current model value.

2.3 N_2O EMISSIONS

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The N_2O emissions in the CA GREET model are fixed at 7.48 g CO_2eq/MJ. None of the user inputs have an impact on this value. There are two factors that have an impact on the calculation: the total quantity of nitrogen applied, and the N_2O emission factor applied. These are discussed below.

2.3.1 Nitrogen Applied

The nitrogen applied is the sum of the synthetic nitrogen fertilizer, nitrogen applied through amendments such as vinasse application, and the above and below ground crop residues. The values in the CA GREET model are listed below.

Table 2-4 Nitrogen Additions to the System

Source	Quantity, g/tonne	CO_2eq Emissions, g/MJ
Synthetic Fertilizer	800	2.88
Crop Residue	1,036	3.73
Filtercake	36	0.13
Vinasse	205	0.74
Total	2,077	7.48

LCFS 46-134

In the CA GREET model the crop residue value is independent of the type of harvest. The model assumes that the nitrogen in the crop residue is returned to the soil as ash. However the data on the fertilizer that is applied does not appear to support this. If the nitrogen in the burned residue is returned to the soil it is not likely returned to the sugarcane field but at some other land.

The proportion of nitrogen from fertilizer and from crop residue should vary depending on whether or not there is straw burning.

2.3.2 N_2O Emission Factor

The model uses the basic IPCC Tier 1 emission factors for the synthetic nitrogen and the crop residues. This includes the direct emissions of N_2O from nitrogen and crops residues, the emissions from nitrogen that is leached from the site and run-off, and the emissions from volatilization of some of the applied nitrogen. This is a misapplication of the IPCC methodology as there should be a small difference between the emission factor for crop residues, which have no volatilization impact and the synthetic fertilizer which does have a volatilization factor. If the factor for synthetic nitrogen is 1.325%, the value for the crop residue should be 1.225%. The 1.325% is made up of:

LCFS 46-135

- 1% of the nitrogen in the synthetic nitrogen and crop residues is emitted as N_2O (EF1).
- 10% of the synthetic nitrogen is volatilized and 1% of that is emitted as N_2O.
- 30% of the N applied is leached or run-off and 0.75% of that is emitted as N_2O.
- Total is 1% + 0.1*1% + 0.3*.075% = 1.325%

The larger issue is whether or not the IPCC Tier 1 default value for EF1 of 1% is appropriate for this region of the world. N_2O emissions are influenced by soil type, precipitation, topography, temperature, and other factors. The GREET model has applied some different factors for different crops but the CA GREET model has applied the same factors for all crops. This will result in underestimating the emissions for some crops and overestimating the emissions for other crops.

2.3.2.1 The Scientific Literature

Sugarcane has a high need for moisture and there is evidence that the N_2O emission factor should be higher due to high levels of precipitation. Renouf et al (2010), in a study of Australian sugarcane production, use an average value of 0.04 for EF1 and report a range of 0.01 to 0.07. Thorburn et al (2010) modeled the N_2O emissions from sugarcane production systems in Australia and determined a range of N_2O emissions form 3-5% of fertilizer applied. Denmard et al (2010) measured N_2O emissions at two sites in Australia and found a range of emissions from 2.8 to 21% of nitrogen in applied fertilizer. The Australian national GHG inventory applies a value of 1.25% for EF1 but it is not clear if this is a Tier 2 value, or simply the Tier 1 value from the 1995 guidelines.

Lisboa et al (2011) looked at this issue for sugarcane production. In addition to the data from Australia they also found data for Hawaii. They determined that the average N_2O emission rate was 3.87%, however while they compare this value to the IPCC EF1 value, they are not comparable. The 3.87% is the total N_2O emissions based just on the nitrogen applied with synthetic fertilizer. It does not include the nitrogen applied from residue or other sources, nor does it include the N_2O from nitrogen leached from the site. Including these would lower the emission factor.

Although information on N_2O emissions for Brazilian sugar cane production is more limited a recent paper by Walter et al. (2014) reported:

> *Experiments in Australia comparing burnt and unburnt harvesting systems indicate that the maintenance of sugarcane straw on the field increases soil N_2O. These results have been recently corroborated by field experiments conducted in Brazil, but with an even more marked increase when vinasse is applied. Because the soil–atmosphere exchange of N_2O depends on complex interactions, more regional and site-specific data are needed to evaluate the impact of this source on the overall GHG balance of biofuels.*

LCFS 46-136

Signor et al (2013) measured the N_2O emissions from sugar cane production at two sites in Brazil. At the first site the proportion of N lost as N_2O ranged from 0.80 to 12.95%. At the second site N_2O emissions varied from 1.22 to 1.53% of added N for ammonium nitrate treatments and from 0.31 to 1.10% for urea.

Experiments reported by da Silva Paredes (2014) found the highest proportions of N emitted as N_2O were registered in the vinasse treatment, which amounted to 15 % of the N applied in the first greenhouse experiment, and 2.5 % in the field experiment, however the N_2O emission rate for just urea were considerably below the Tier 1 default value of 1%.

Vargas et al (2014) investigated the impact of soil moisture and the level of trash retained in the soil and found that N_2O emissions increase with soil moisture and the presence of trash on the soil doubled the impact of increasing soil moisture on N_2O emissions.

Although there is significant uncertainty with respect to the N_2O emission factor for sugar cane production in Brazil, the scientific literature indicates that rates are higher when the fields are not burned and the trash remains on the field. Rates are also higher when vinasse is applied to the field. More work has been done in Australia and corroborated with field experiments in Brazil, and all of that work suggests that the appropriate emission factor is greater than the 1% value for EF1 that has been used by CARB.

2.4 SUGAR CANE FARMING SUMMARY

The CA GREET model does not apply different energy use factors to sugar cane farming even though the two scenarios with mechanical harvesting require almost twice the energy of a manual harvest system. A mechanical harvest system with 100% of the energy supplied by diesel fuel will have GHG emissions of 7.54 g CO_2eq/MJ.

There is evidence that the crop residues that are left on the field are reducing the synthetic nitrogen that is required. The proportion of nitrogen from fertilizer and from crop residue should vary depending on whether or not there is straw burning. The CA GREET model is assuming that there is no difference in nitrogen requirements between burned and unburned fields, an unlikely scenario.

Although there is significant uncertainty regarding the appropriate N_2O emission factor for sugar cane production, the best information in the peer reviewed literature indicates that the 1% EF1 factor used by CARB is too low. The impact of increasing this to 1.5% is an increase in sugar cane N_2O emissions of 2.83 g CO_2eq/MJ.

LCFS 46-137

3. STRAW BURNING

For fields that are not mechanically harvested the CA GREET model assumes that the fields are burned prior to harvesting. This does result in different values for the manual versus mechanical harvested scenarios, where a credit for the burning emissions is introduced in the mechanical harvesting systems.

In the GREET model all of the nitrogen in the straw is included in the crop residue whether the straw is burned or is left on the soil. This is not likely to be the case but correcting it would result in lower emissions for fields that are burned and no change in the emissions for mechanical harvesting.

Even though the straw is biogenic the methane emissions and the N_2O emissions must still be included in the calculations of GHG emissions. The emission factors used in GREET are shown in the following table.

LCFS 46-138

Table 3-1 Straw Emission Factors

	CA GREET	IPCC Grassland	IPCC Ag residue
	g/tonne		
Methane	2,700	2,300	2,700
N_2O	7	21	7

CA GREET also converts the CO and VOC emissions to CO_2eq for straw burning and then provides a credit for the carbon uptake from the atmosphere. This essentially uses the biogenic methane GWP factor of 22.25.

The IPCC values shown above are for grassland burning and for Ag residue burning, as there are no specific emission factors for sugarcane field burning. The source of the IPCC estimates is the paper by Andrea & Merlet (2001). In that paper there are over 40 references to support the grassland estimates and the note beside the Ag residue value is “Value is a best guess”.

The GHG emissions for straw burning would increase to 14.42 g CO_2eq/MJ if the IPCC Grassland values were used rather than the Ag residue values.

3.1 STRAW BURNING SUMMARY

LCFS 46-139

The straw burning emissions are too low by about 4.43 g CO_2eq/MJ as a result of using the IPCC emission factors for Ag residue burning rather than the values for grassland and savanna burning. This increase would be reduced to about 2.5 g CO_2eq/MJ if the nitrogen from the burned straw was not returned to the soil as discussed in the previous section.

4. CANE TRANSPORTATION

The cane transportation distance is a user input to the CA GREET model. They have modelled both a medium duty and a heavy duty truck. This is appropriate because both types of trucks can be used, although they have assigned a 100% share to both types and the share is not a user input. Either one or the other will be used, not both. The share should also be a user input.

The same energy use is used for HD and MD trucks for all pathways in the model. Sugar cane transport it usually at lower speeds than highway travel in North America but the roads are generally dirt, so the assumption of the same energy use is probably reasonable.

The transportation distance is the user input and it is the key parameter in driving the GHG emissions.

LCFS 46-140

4.1 CANE TRANSPORT SUMMARY

The model should be changed so that the share of the delivery of cane by medium duty trucks and by heavy duty trucks is a user input. The truck energy requirements are the same as for corn ethanol.

5. ETHANOL PLANT

The GHG emissions from the ethanol plant stage using the default values in the CA-GREET model amount to 2.30 g CO_2eq/MJ, or less than 10% of the lifecycle emissions for each of the 4 scenarios. The composition of the total is discussed below.

5.1 ENERGY USE

The T1 Calculator sheet asks for total energy use in the mill by type of energy. The calculator as produced only includes some residual oil use and some electric power use. It has zero for biomass use. All of the 2.30 g CO_2eq/J of emissions are energy derived.

Sugar cane mills burn a lot of bagasse to provide the power and the steam for the mills. This biomass is hardcoded into the model and is not adjusted when a user enters biomass energy into the T1 Calculator sheet. It is also not included in the energy consumption values. If a mill imported bagasse or straw to produce more electricity, the model will not produce higher emissions as a result of the higher biomass inputs.

The contribution of the default energy values to the total for this stage is shown in the following table. Even though the bagasse is biogenic the methane and N_2O emissions are still included in the calculations.

LCFS 46-141

Table 5-1 Ethanol Plant Energy Related Emissions

Type	Value	Emissions
	BTU/gal	G CO_2eq/MJ
Residual oil (10% loss of lubricants)	300	0.04
Power	24.37	0.00
Bagasse	89,272	2.26
Total	89,596.37	2.30

Most of the emissions are related to methane and N_2O emissions from burning the bagasse. It is not clear on the T1 Calculator sheet that the residual oil use is related to lubricants and users will likely try and zero this value out when they use the calculator.

5.2 CHEMICALS

The two chemicals that are included in the T1 Calculator sheet are sulphuric acid and ammonia. Both are zero in the model. Seabra (2011) reports sulphuric acid consumption in the mills of 0.0074 kg/litre, 28 g/gal. The model is broken as it transfers the 28 g of sulphuric acid to cell DU 357 (Alpha Amylase) on the EtOH sheet rather than to DU 361 (Sulphuric Acid). This results in GHG emissions of 169,460 g CO_2eq/MJ for the ethanol production stage, an obvious error. The ammonia also goes to the wrong cell on the EtOH sheet.

LCFS 46-142

The CA GREET model for Tier I applications doesn't apply to mills that produce sugar and ethanol. These need to be done using the Tier 2 methodology, but are still expected to be done using the CA GREET model as the base. These mills use some lime in the production process (Seabra reports 42.6 g/gal). There is no provision in CA GREET for including lime as an input to the ethanol production process. This needs to be added as user input. Lime has GHG emissions of about 1.25 g/g CAO so including this chemical would add about 0.7g CO_2/MJ to the ethanol production emissions.

5.3 POWER EXPORTS

The new CA-GREET model is using the average power mixes rather than trying to estimate the marginal power in all of the different regions that are included in the model. In the case of Brazil, this drastically lowers the credit for power exports. LCFS 46-143

There is an error in the CA-GREET model with respect to the Brazilian power mix. When the data is migrated from the T1 Calculator sheet to the ETOH sheet the values for nuclear and biomass power are transposed. The values in cells Q293 and Q294 on the ETOH sheet are therefore incorrect and lead to a slightly higher credit (~0.1 g/MJ) than should be calculated. LCFS 46-144

A larger issue is the quality of the data being used in the model for Brazil power. The power mix for Brazil that is used in CA-GREET is shown in the following table. The source identified for the data is the US DOE EIA country brief. This brief was updated in December 2014 and the results are also shown in the table. Small amounts from wind, solar, and nuclear made up the rest. LCFS 46-145

Table 5-2 GREET Brazil Power Mix

	Brazilian Mix in Model	Updated EIA Brief
Resid Oil/Fossil fuels	0.00%	4%
Natural gas	11.00%	11%
Coal	0.00%	0%
Nuclear power	2.00%	0%
Biomass	7.00%	8%
Hydroelectric	55.76%	71%
Geothermal	3.33%	0%
Wind	20.65%	0%
Solar PV	0.26%	0%
Others (purchased)	0.01%	0%
Total	100.01%	94.00%

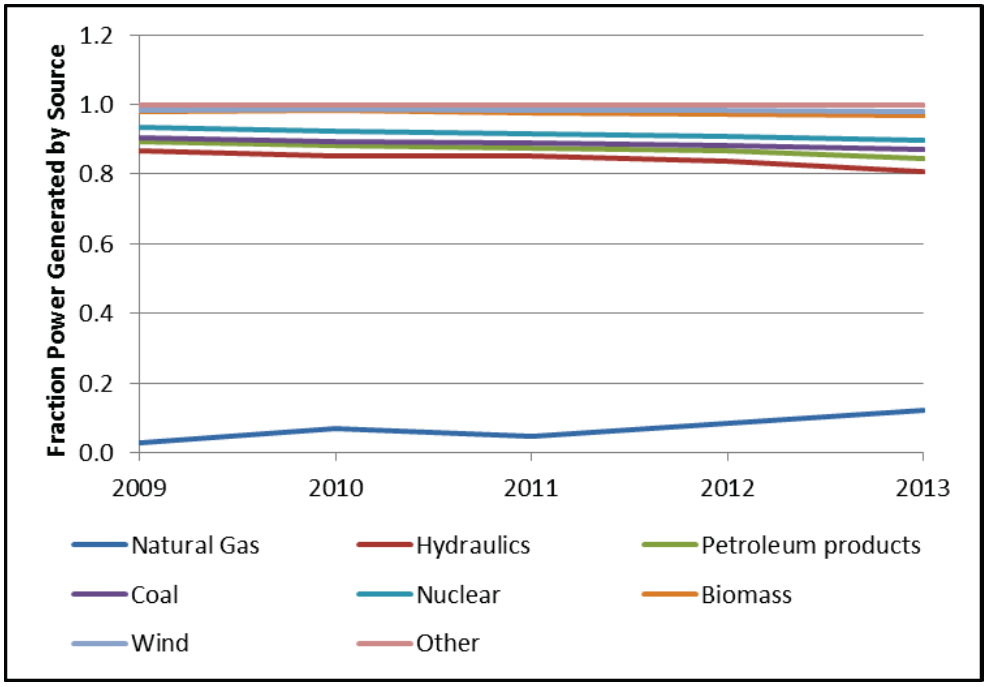
There is a better source of electrical power generation in Brazil. The Energy Research Company - EPE publishes a Statistical Review of the Electric Sector (EPE, 2014). The information from that source is shown below.

Table 5-3 Actual Brazil Power Mix

	2009	2010	2011	2012	2013
Natural Gas	2.86%	7.07%	4.72%	8.46%	12.11%
Hydro	83.87%	78.19%	80.55%	75.18%	68.59%
Petroleum products	2.73%	2.76%	2.30%	2.93%	3.88%
Coal	1.16%	1.36%	1.22%	1.52%	2.60%
Nuclear	2.78%	2.82%	2.94%	2.90%	2.57%
Biomass	4.69%	6.05%	5.95%	6.27%	6.96%
Wind	0.27%	0.42%	0.51%	0.91%	1.15%
Other	1.64%	1.34%	1.81%	1.81%	2.15%
Total	100.00%	100.00%	100.00%	100.00%	100.00%

CARB underestimates the natural gas, coal, and oil used for power generation in Brazil. Furthermore the quantity of gas being used is increasing with time as shown below. The fossil fuel fraction has increased 275% since 2009.

Figure 5-1 Power Generation Trends



Using a more accurate estimate of the Brazilian power mix will slightly increase the base emissions but also increase the power credit available for plants that export power to the grid.

LCFS 46-145 cont.

5.4 Ethanol Production Summary

There are several errors in the CA GREET model related to the transfer of information from the T1 Calculator sheet to the core of the model. These include:

1. Nuclear and biomass power shares of the power generation are transposed when they are transferred to the ETOH sheet.
2. The inputs for sulphuric acid and ammonia are input into the cells for enzymes when they move from the T1 Calculator sheet to the ETOH sheet. Entering non-zero values will produce extremely high and erroneous GHG emissions.

LCFS 46-146

There is also the potential for misinterpretation of the input values. The input for Residual oil is really the quantity of used lubricants that are burned in the plant and not the input of residual oil.

LCFS 46-147

The quantity of biomass that is burned at the plants is hard coded in the model. Not all mills burn all of the bagasse on site; some sell a portion to other local industries. The emissions for these operations will be overestimated. The biomass from the T1 Calculator sheet is transferred to the ETOH sheet, but once it goes there it is not included in any calculations. Proper modelling should require the mills to enter the bagasse consumed and not hard code those quantities. The current model would underestimate the emissions from mills that

LCFS 46-148

imported bagasse from another facility or used some straw from the fields to produce more electric power for export.

LCFS 46-148 cont.

6. ETHANOL TRANSPORTATION

Ethanol can be transported from Brazil to California by truck, rail, and pipeline in Brazil, by ocean tanker, and then by truck in California. In CA-GREET the user will select the transportation distances and the distances for each mode on the T1 Calculator sheet. The values in the calculator create emissions of 7.16 g CO_2e/MJ with only the Brazilian truck, ocean freight and the California Port to blending stations being non-zero inputs. The distance from the blending point to the service station is a non-adjustable system input for all types of ethanol; however the distance is different for sugarcane ethanol compared to corn ethanol (50 miles vs. 40 miles). They should be the same.

LCFS 46-149

Table 6-1 Transportation Emissions

Mode	Distance	Emissions
Brazil Truck	130	1.01
Ocean Ship	8,758	5.06
US Truck	90	0.70
Truck to Service Station	50	0.39
Total		7.16

The Brazilian trucking distance is short but that will have to be filled in by the applicant for the specific mill.

The issue for modelling is the calculation of the ocean shipping emissions. There are three issues with the calculation which lead to an inaccurate assessment of the emissions. These are described below.

6.1 BACKHAUL

All of the ocean movements in the CA GREET model, ***except Brazilian ethanol***, have an energy charge for the primary movement and the backhaul movement. This backhaul charge is 84% of the energy of the one-way movement. There is no backhaul charge for the Brazilian ethanol. If there was, the emissions would increase by 3.43 g/MJ. The model should be revised to include backhaul as a default value whenever an applicant cannot prove that there will be no backhaul for the relevant pathway.

LCFS 46-150

6.2 SHIPMENT SIZE

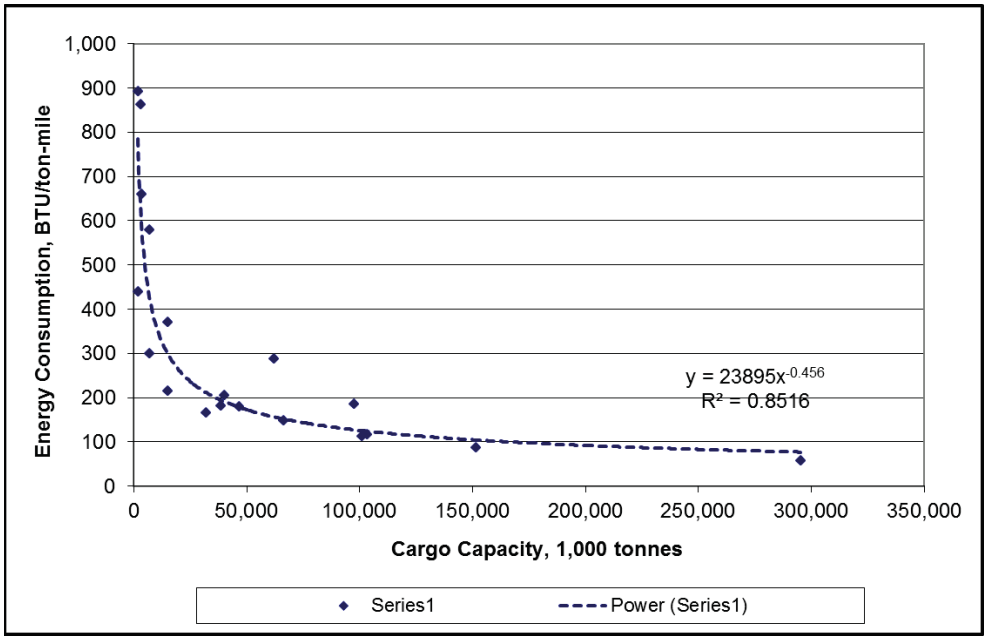
The CA GREET model assumes that the ethanol is delivered in 22,000 tons shipments. The US DOE EIA reports petroleum product imports on a company level basis. The 2014 data for the first 10 months of the year is currently available. Sugarcane ethanol from Brazil, Guatemala, and Nicaragua has been received in the US. No Brazilian ethanol has been landed in California during this time period. The average size of the shipment was 11,200 tons. This includes shipments that were delivered to more than one port as a single load of the combined capacity. This is only half of the value in the model and it will result in the energy and thus the emissions being underestimated. The model should be revised to require a verifiable shipment size as a user input.

LCFS 46-151

6.3 VESSEL ENERGY REQUIREMENTS

The size of the ship has a large impact on the energy expended; larger ships require less energy to move the cargo. The International Maritime Organization (IMO, 2008) published data on the GHG emissions for various sizes of ships. The GHG emissions are easily converted to energy and the relationship for a range of chemical, petroleum product, and crude oil carriers are shown in the following figure. The energy consumption is very sensitive to vessel size, especially for the small vessels, and the energy can increase by 50% of more moving from a 22,000 ton vessel to an 11,000 ton vessel.

Figure 6-1 Energy Requirements vs. Vessel Size



The energy use for the 22,000 ton shipment in GREET is 140 BTU/ton-mile and it excludes the backhaul. The IMO estimate for an 11,000 ton shipment is 343 BTU/ton-mile. To this would be added the 84% for a back haul, for a total energy use of 631 BTU/ton-mile or 4.5 times more than the CA GREET model estimates. This would add about 17.5 g/MJ to the Brazilian sugarcane ethanol carbon intensity for pathways that cannot verify that there is no backhaul.

The calculation of energy consumption in GREET is based on theoretical calculations, includes some erroneous correlations, and underestimates the real world energy use. For example, the faster a ship travels the more power is consumed, but in GREET the energy consumption decreases with faster travel. This is because the power requirements increase as the cube of the velocity in the real world but in GREET the power requirements are independent of the speed. The energy consumed per mile is a function of the square of the speed, or power divided by speed. GREET uses the power/speed equation but doesn't account for the power being a function of the speed, so the end calculated result is incorrect. The model must be revised to correct the errors.

LCFS 46-152

6.4 TRANSPORTATION SUMMARY

There are significant issues with the ocean shipping calculations in GREET for many of the fuels, including sugarcane ethanol. The issues for sugar cane ethanol include:

1. The shipment size of 22,000 tons is too high and is not a user input.
2. Sugar cane Ethanol from Brazil, uniquely of all of the fuels in CA GREET, is not charged with a backhaul.
3. The energy use for ocean shipping is calculated but the calculations underestimate the energy used by a significant amount.
4. Energy use in the model is 145 BTU/ton-mile. Data from the IMO suggests that this should be 335 BTU/ton-mile plus 283 BTU/ton-mile for the backhaul. This would increase the ocean shipping emissions by 17.0 g CO_2eq/MJ, a very significant difference.

LCFS 46-151 cont.

LCFS 46-150 cont.

LCFS 46-152 cont.

7. DISCUSSION

The sugar cane ethanol pathway in the new CA GREET 2.0 model has been thoroughly reviewed. The review has considered the following questions.

- Are the pathways consistent?
- Does the model ask for the key input parameters?
- Does the model reflect the actual practices?
- Does the model have the correct background data and are the calculations correct?

A significant number of issues were identified. Most of the issues results in the model returning values that are lower than what would be returned if the issues were addressed properly.

7.1 SUGAR CANE FARMING SUMMARY

The CA GREET model does not apply different energy use factor to sugar cane farming even though the two scenarios with mechanical harvesting require almost twice the energy of a manual harvest system. A mechanical harvest system with 100% of the energy supplied by diesel fuel will have GHG emissions of 7.54 g CO_2eq/MJ.

There is evidence that the crop residues that are left on the field are reducing the synthetic nitrogen that is required. The proportion of nitrogen from fertilizer and from crop residue should vary depending on whether or not there is straw burning. The CA GREET model is assuming that there is no difference in nitrogen requirements between burned and unburned fields, an unlikely scenario.

Although there is significant uncertainty regarding the appropriate N_2O emission factor for sugar cane production, the best information in the peer reviewed literature indicates that the 1% EF1 factor used by CARB is too low. The impact of increasing this to 1.5% is an increase in sugar cane N_2O emissions of 2.83 g CO_2eq/MJ.

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7.2 STRAW BURNING SUMMARY

The straw burning emissions are too low by about 4.36 g CO_2eq/MJ as a result of using the IPCC emission factors for Ag residue burning rather than the values for grassland and savanna burning. This increase would be reduced to about 2.5 g CO_2eq/MJ if the nitrogen from the burned straw was not returned to the soil as discussed in the previous section.

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7.3 CANE TRANSPORT SUMMARY

The model should be changed so that the share of the delivery of cane by medium duty trucks and by heavy duty trucks is a user input. The truck energy requirements are the same as for corn ethanol.

LCFS 46-155

7.4 ETHANOL PRODUCTION SUMMARY

There are several errors in the CA GREET model related to the transfer of information from the T1 Calculator sheet to the core of the model. These include:

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1. Nuclear and biomass power shares of the power generation are transposed when they are transferred to the ETOH sheet.
2. The inputs for sulphuric acid and ammonia are input into the cells for enzymes when they move from the T1 Calculator sheet to the ETOH sheet. Entering non-zero values will produce extremely high and erroneous GHG emissions.

LCFS 46-156 cont.

There is also the potential for misinterpretation of the input values. The input for Residual oil is really the quantity of used lubricants that are burned in the plant and not the input of residual oil.

The quantity of biomass that is burned at the plants is hard coded in the model. Not all mills burn all of the bagasse on site; some sell a portion to other local industries (San Martinho, 2007). The emissions for these operations will be overestimated. The biomass from the T1 Calculator sheet is transferred to the ETOH sheet, but once it goes there it is not included in any calculations. A proper modelling would require the mills to enter the bagasse consumed and not hard code those quantities. The current model would underestimate the emissions from mills that imported bagasse from another facility or used some straw from the fields to produce more electric power for export.

LCFS 46-157

7.5 Transportation Summary

There are issues with the ocean shipping calculations in GREET for many of the fuels, including sugarcane ethanol. The issues for sugar cane ethanol include:

1. The shipment size of 22,000 tons is too high and is not a user input.
2. Ethanol, uniquely of all of the fuels in CA GREET, is not charged with a backhaul.
3. The energy use for ocean shipping is calculated but the calculations underestimate the energy used by a significant amount.
4. Energy use in the model is 145 BTU/ton-mile. Data from the IMO suggests that this should be 335 BTU/ton-mile plus 283 BTU/ton-mile for the backhaul. This would increase the ocean shipping emissions by 17.0 g CO_2eq/MJ, a very significant difference.

LCFS 46-151 cont.

LCFS 46-150 cont.

LCFS 46-152 cont.

7.6 Summary

With respect to the four questions that were investigated we find that:

1. There are inconsistencies between some aspects of the sugarcane ethanol pathway and all other pathways.
2. There are key input parameters that should be included in the model. These would include, the share of cane transported by MD and HD trucks, the ocean shipment size, and confirming that a backhaul is always provided.
3. The model does not reflect actual practice. The lack of change in the farming emissions with the different practices that are employed is problematic. The ocean shipping size is double the typical shipments.
4. The background data in the model is not accurate. The biggest issue is with the energy used for ocean shipping but the emission factor applied to cane burning should be changed.

LCFS 46-158

LCFS 46-159

LCFS 46-160

LCFS 46-161

In addition, there are some programming errors in the calculator that need to be adjusted. Correcting the issues in the model will increase the GHG emissions in the different scenarios. The following two tables itemize the changes that should be made to the model.

Table 7-1 Summary of Changes - Farming

Stage	Manual Harvest			Mechanical Harvest		
	Default	Revised	Change	Default	Revised	Change
All Diesel	4.65	5.39	0.74	4.65	5.39	0.74
Extra Diesel for Mech Harvest					7.54	2.15
Extra N Fert for manual	3.22	4.43	1.21			
N_2O from extra N	2.88	3.96	1.08			
Total			3.03			2.89

Table 7-2 Changes to Rest of Pathway

Item	Default	Revised	Change
N_2O EF	7.48	10.31	2.83
Residue Leaching		7.13	-0.35
Straw Burning EF	10.06	14.42	4.36
Power Export	-0.72	-0.76	-0.04
Shipping			
Backhaul	7.16	11.41	4.25
Ship size		18.88	7.47
IMO Energy		24.15	5.27
Total			23.79

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17_OP_ADF_GE Responses (Page 118 – 148)

102. Comment: **LCFS 46-130 through LCFS 46-162**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Regulation Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

Appendix D

Appendix D

Compliance with the Revised LCFS Program and Associated Economic Impacts

Prepared by Edgeworth Economics

CARB's proposed changes in the LCFS regulation call for a reduction in the carbon intensity (CI) of gasoline relative to the baseline level of 99.18 by 2 percent in 2016, 5 percent in 2018, and 10 percent in 2020.[1] In theory, the strategies to achieve those reductions could include 1) displacing gasoline usage with other types of fuel with lower CI values (*e.g.*, electricity); 2) changing the current limit on the percentage of ethanol that can be blended into California gasoline below the E85 level (which is E10); 3) reducing the average CI of renewable fuel blended with gasoline under the E10 limit; and 4) deployment of credits generated from the use of renewable fuels prior to 2016 and the use of renewable fuels in diesel after 2016. CARB projects that compliance with the LCFS will rely significantly on the third method through at least 2020.[2] This Appendix to Growth Energy's comments identifies the circumstances under which the LCFS program will shift the supply of ethanol for the California market from the United States to Brazil, as a result of strategies to reduce the average CI of renewable fuels blended into gasoline under the E10 limit.

Through 2020, CARB has projected that compliance with the LCFS could be reached primarily through a shift from corn ethanol, now largely sourced from the Midwest[3] with an average CI value of about 82, to cane ethanol from Brazil, which currently has an average CI value of about 72.[4] CARB developed an "illustrative compliance scenario" which projects a reduction in corn ethanol use in California gasoline from the current (2014) level of 1,250 million gallons per year to 700 million gallons per year in 2020, with an increase in consumption of cane ethanol equal to about 64 percent of that reduction. Thus, CARB's scenario would

[1] CARB, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking*, December 2014 ("ISOR"), p. ES-3.
[2] ISOR, p. B-39.
[3] The Renewable Fuels Association (RFA) lists three operating corn ethanol plants in California, with total capacity of 175 million gallons per year, representing about one percent of total U.S. ethanol production and about 14 percent of consumption in California. [RFA website at www.ethanolrfa.org/bio-refinery-locations]
[4] ISOR, p. B-39.

involve a reduction in consumption of Midwest-sourced corn ethanol of about 550 million gallons per year as of 2020, relative to today, equivalent to the entire output of about seven typical-sized ethanol plants.[5]

CARB presents the foregoing scenario as an example of how compliance could be achieved. CARB bases its analysis of the economic impacts of the LCFS on an assumption that credit prices would equal $100 from 2016 through 2020.[6] CARB also evaluates economic-impact scenarios based on assumed credit prices of $25, the current value as of January 2015, and $57, the average value from 2012 to 2013.[7]

To determine whether credit prices at those levels would, in fact, cause fuel marketers in California to switch from Midwest-based corn ethanol to Brazilian cane ethanol, Edgeworth Economics prepared an analysis of the total, delivered cost of both fuels under various assumptions about the CI for each type. Our analysis uses the following data:

- A CI range for Midwest-based corn ethanol of 81.4 to 92.4, representing a range of ratings for ethanol refineries located in the Iowa/South Dakota/Minnesota area that currently ship product to California, based on CARB's list of "Approved Physical Pathways" and information provided by Growth Energy members.
- A CI range for Brazilian cane ethanol of 72.5 (current) to 40 (as of 2016), as reported in the ISOR at p. B-39.
- Ethanol spot prices at Chicago, IL and Santos, Brazil—2014 average [source: Platts] and 2016 forecast [source: OECD-FAO, *Agricultural Outlook 2014-2023*].
- Rail freight rates from Midwest refinery locations to California, provided by Growth Energy members.
- Maritime freight rates from Brazil to California, including tariff and terminal charge [source: Odin Marine Group, *Ethanol Report*, January 2015 and Growth Energy members].

[5] The average output of operating ethanol facilities is about 76 million gallons of ethanol per year. [RFA website at www.ethanolrfa.org/pages/statistics]
[6] ISOR, p. VII-1.
[7] ISOR, pp. VII-1-2 and "Monthly LCFS Credit Transfer Activity Report for January 2015" [CARB website at www.arb.ca.gov/fuels/lcfs/credit/20150210_jancreditreport.pdf]

- D5 and D6 Renewable Identification Number (RIN) prices—2014 average [source: OPIS].

Because the delivered cost of Brazilian ethanol in California is substantially higher than the cost of Midwest corn ethanol at present, with LCFS credit levels around $25, relatively little cane ethanol is imported into California[8], while Midwest facilities with CI ratings in the low 90s continue to deliver product. At the average ethanol and RIN prices experienced in 2014, the value of an LCFS credit would need to rise to $156 in order to incentivize a switch from the highest-CI-rated Midwest sources to Brazil. The spread between prices for conventional (D6) RINs and advanced biofuel (D5) RINs has recently expanded, which provides additional incentive to import cane ethanol from Brazil. Based on the average spread in January 2015, an LCFS credit price of $105 would incentivize the same switch.

However, based on forecasts for ethanol prices in 2016, which show a narrowing of the price differential between U.S. and Brazilian ethanol, an LCFS credit price of about $36 (based on 2014 RIN spreads) would cause a switch from 92.4-CI corn ethanol to cane ethanol; and a credit price of only $77 would cause a switch from 81.4-CI corn ethanol to cane ethanol. These figures are well below CARB's estimate for LCFS credit prices of $100 in 2016.

If Brazilian cane ethanol can receive the CI ratings predicted by CARB, then the switch will occur at even lower credit prices. For example, CARB projects that Brazilian ethanol will have an average CI rating of 40.0 by 2016.[9] At that rating, LCFS credit prices as low as $14 would result in a switch away from the higher-rated facilities in the Midwest, and credit prices as low as $17 would result in a switch away from even the lower-rated Midwest facilities.[10] In this scenario, even Midwest facilities with CI ratings as low as 70, which CARB claims will be the average rating of the Midwest corn facilities still delivering product to California as of 2016[11], would be at risk. Credit prices as low as $23 would be sufficient to induce a switch to imported cane ethanol. CARB's scenario indicating a substantial decline in the use of Midwest corn ethanol in California and an increase in the use of imported cane ethanol is therefore not only

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[8] CARB estimates 100 million gallons in 2014. [ISOR, p. B-39]
[9] ISOR, p. B-39.
[10] These figures are calculated using the 2016 forecast for ethanol prices and current RIN spreads.
[11] ISOR, p. B-39.

plausible, but probable if sufficient ethanol is available from Brazil, even at modest credit prices well below CARB's projected level of $100.[12]

The implications for Midwest ethanol producers in this scenario would be severe. Assuming that U.S.-wide demand for ethanol does not increase (the Energy Information Administration projects ethanol consumption will be flat through 2016[13]), then the increased imports of Brazilian ethanol would result in some combination of 1) lost production or shut-down of Midwest facilities—with total lost volumes equivalent to as many as approximately seven typical-sized plants by 2020, as noted above; or, at a minimum, 2) increased logistics costs associated with exporting corn ethanol to the nearest source of demand outside the U.S., which could be Brazil. Obviously, the latter outcome would not result in a decrease in world-wide carbon emissions.

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The economic impact of reduced production levels or complete plant closures in the Midwest can be estimated based on the characteristics of typical ethanol refineries. On average, U.S. corn ethanol facilities employ approximately 0.8 employees per million gallons of ethanol produced, or about 61 employees for a typical plant.[14] A reduction in ethanol demand of 550 million gallons per year therefore would result in a direct loss of approximately 440 jobs at ethanol refineries. In addition to these direct effects, the regions that host ethanol production facilities would experience additional reductions in economic activity stemming from reduced purchases of locally-sourced inputs (the "indirect" impact) and reduced spending by facility employees and local vendors (the "induced" impact). These additional economic impacts are generated by the "multiplier" effect, which results from the recycling of business revenues and household income within the local region. Plausible estimates for the overall multiplier effect for employment applicable to the ethanol industry range from about 2 (indicating a total impact

[12] This result holds even if the price differential between U.S. and Brazilian ethanol remains closer to current levels, rather than declining as indicated in the forecast described above.
[13] U.S. Energy Information Administration, *Short-Term Energy Outlook*, February 10, 2015.
[14] Based on various sources, including: John Urbanchuk, "Contribution of the Ethanol Industry to the Economy of the United States," Cardno ENTRIX, prepared for the Renewable Fuels Association, February 2, 2012; David Swenson, "Understanding Biofuels Economic Impact Claims," Iowa State University, April 2007; and various public SEC filings.

on employment equal to two times the direct employment impact) to about 7.[15] Applying a figure of 4 to the direct employment impacts calculated above implies a loss of approximately 1,760 jobs in ethanol producing regions.

Even assuming that the facilities forced out of the California market could find customers outside the U.S., there would still be substantial costs to the industry. For example, transport of ethanol from the Midwest to Brazil would entail increased logistics costs of approximately 10 cents per gallon[16], or $55 million per year, assuming sufficient demand in Brazil for all 550 million gallons of displaced corn ethanol.

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[15] See, for example, Urbanchuk, February 2, 2012, *op. cit.*; Swenson, April 2007, *op. cit.*; Susan Christopherson and Zachary Sivertsen, "Economic Policy Makers Beware: Estimating the Job Impact of Public Investment in Biofuel Plants," working paper, Cornell University, December 12, 2009; and Dave Swenson, "Input-Outrageous: The Economic Impacts of Modern Biofuels Production," Iowa State University, June 2006.

[16] Based on the sources described above.

17_OP_ADF_GE Responses (Page 149 – 154)

103. Comment: **LCFS 46-163**

Agency Response:
This response to this comment is in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

Appendix E

Nos. 12-15131, 12-15135

UNITED STATES COURT OF APPEALS FOR THE NINTH CIRCUIT

ROCKY MOUNTAIN FARMERS UNION, *et al.*, Plaintiffs-Appellees,

v.

JAMES N. GOLDSTENE, *et al.*,Defendants-Appellants, and ENVIRONMENTAL DEFENSE FUND, *et al.*,Intervenor-Defendants-Appellants.

Appeal from the United States District Court for the Eastern District of California (D.C. Nos. 1:09-cv-02234-LJO-GSA, 1:10-cv-0013-LJO-DLB)

DECLARATION OF ERIN HEUPEL, P.E.

I, Erin Heupel, declare and state as follows:

1. I am the Director of Environment and Technology at POET LLC, a company that constructs and manages ethanol production facilities, headquartered in Sioux Falls, South Dakota. I provide this declaration in support of the opposition by Plaintiffs-Appellees ("Plaintiffs") to the motion filed by Defendants-Appellants ("Defendants") to stay the preliminary injunction and judgments in *Rocky Mountain Farmers Union, et al. v. Goldstene*, Case No. 1:09-cv-02234-

LJO-GSA (E.D. Cal., Dec. 29, 2011).[1] I am a licensed Professional Engineer in the States of Iowa and South Dakota. I make this declaration based on my professional experience and my personal knowledge of the facts set forth herein. I am willing and able to present under oath the facts set forth in this Declaration if called as a witness before the Court.

2. The purpose of this declaration is to respond to statements in the Declaration of Michael Waugh, dated January 20, 2012, and filed in this Court by Defendants on February 10, 2012, on two subjects: (i) the creation of "individualized" pathways for some corn ethanol plants under the California low-carbon fuel standard ("LCFS") regulation, and (ii) the impact of District Court's preliminary injunction on the environmental benefits that Defendants attribute to the LCFS regulation. *See* Declaration of Michael Waugh in Support of Defendants and Defendant-Intervenors' Motion to Stay Preliminary Injunction and Judgments Pending Appeal (Dkt Entry 21-7) ("Waugh Decl.") ¶¶ 5, 39-41, 52-59, *and id.* at 11:9.

3. I am in charge of the efforts of ethanol plants managed by POET LLC, to receive CARB approved individualized carbon intensity "pathways" for

[1] *See* Motion for A Stay of the District Court's Orders and Judgments Pending Appeal (Dkt Entry 22-1) ("Stay Mot.").

the plants managed by POET LLC that can qualify for such pathways.[2] My duties at POET LLC require me to have complete knowledge of the technologies, processes, and methods used for the production of corn ethanol and various co-products by the plants that POET LLC manages, including the production efficiencies and energy requirements of those plants. My responsibilities at POET LLC also require me to have substantial knowledge of the same attributes of corn ethanol plants that compete with the plants that POET LLC manages.

4. At the outset, it is important to understand that companies in the U.S. corn ethanol industry have strong commercial incentives to maximize yield from feedstock and to minimize energy usage, and thus to minimize greenhouse gas ("GHG") emissions. Corn ethanol plants cost millions of dollars to build. Midwest corn ethanol plants are carefully sited in order to have ready access to their feedstock, as well as competitively priced natural gas, electricity, or other sources of energy to run the plant. The companies that survive and prosper in this industry are those whose plants are designed from the beginning for maximum efficiency in feedstock conversion and minimum energy consumption. Next to corn costs, energy costs are the largest variable cost in producing corn ethanol.

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[2] *See* Waugh Decl. ¶¶ 52-56. The plants that POET LLC constructs and/or manages are owned by separate investor groups. *See* Declaration of Robert Whiteman (filed March 1, 2012) at note 3.

5. A number of plants managed by POET LLC have received CARB staff approval for 11 different individualized pathways for corn ethanol. I am personally familiar with the attributes of each plant awarded those pathways that the LCFS regulation treats as relevant in determining the carbon intensity of the ethanol that those plants produce. The relevant plants made no changes in production methods, feedstock, methods of transport, or any other factor relevant to the pathway application, in order to reduce the carbon intensity that would be assigned to ethanol produced at those plants. POET LLC obtained the CARB approved CI pathways for these plants by documenting the attributes of production and energy supply relevant under the LCFS regulation that those plants had adopted for commercial reasons, completely independent of the LCFS regulation and the regulation's requirements for the establishment of alternative pathways.

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6. When plants managed by POET LLC make changes in their technologies, production methods, or energy sources, and those changes reduce the carbon intensity, POET LLC seeks changes in the carbon intensity values that apply to those plants to the extent possible under the LCFS regulation. In such instances, however, the motivating factor for the change at the plant is not the LCFS regulation, but the need to remain competitive in production methods and technologies within the Midwest corn ethanol industry. In addition, to my knowledge, none of the Midwest corn ethanol plants that compete with those

managed by POET LLC have made changes in their technologies, production methods, or energy inputs in order to gain a lower carbon intensity value under the LCFS regulation; instead, those plants strive to increase efficiency and reduce energy consumption for the same commercial reasons as the plants managed by POET LLC.

7. The LCFS regulation becomes more stringent in each year after 2011. But, contrary to what appears to be the position taken in Mr. Waugh's declaration, it would not be commercially practicable for Midwest corn ethanol plants to try to keep up with the increases in the stringency of the regulation, simply in order to try to stay in business in California.[3]

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8. Under the LCFS regulation, all corn ethanol plants, including those in the Midwest, must add an assigned "indirect" carbon intensity emissions factor of 30 gCO_2eq/MJ to their "direct" carbon intensity emissions factor. The "indirect" emissions factor is more than 40 percent of the total carbon intensity level assigned to the corn ethanol pathway that, according to Mr. Waugh's Declaration, has the lowest carbon intensity level recognized by the CARB staff.[4] Nothing that any

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[3] *See* Waugh Decl. ¶¶ 41, 44.

[4] *See* Waugh Decl., Exh. E at 8 (pathway value of 73.21 gCO_2eq/MJ for Pathway No. ETHC0035). The pathway that Mr. Waugh's declaration identifies as the "lowest carbon intensity value approved for any ethanol," for a plant located in Kansas (Waugh Decl. ¶ 53), is a pathway for a plant that uses the combination of wheat slurry, sorghum, and corn and is not a pathway for an ethanol plant using

single corn ethanol plant or group of corn ethanol plants can do will reduce the "indirect" carbon intensity emissions factor assigned by the LCFS regulation. As a result, the impact of plant changes in improving efficiency or reducing energy consumption do not result in proportional changes in the assigned CI value. For example, the 73.21 gCO_2eq/MJ value above consists of 43.21 gCO_2eq/MJ for the production of feedstock and ethanol as well as ethanol transport and the value of 30 gCO_2eq/MJ for indirect emissions. A 10% reduction in the 43.21 gCO_2eq/MJ value to 38.89 gCO_2eq/MJ yields only a 6% reduction in the overall CI value which becomes 68.89 gCO_2eq/MJ. In addition, within the "direct" emissions factor assigned to a corn ethanol plant, the LCFS regulation attributes a substantial increment to GHG emissions attributed to the cultivation and harvesting of corn (potentially, 35.7 gCO_2eq/MJ). Ethanol plants cannot directly control and document how farmers grow and harvest corn, which the farmers grow not only to

LCFS 46-166 cont.

corn. Sufficient quantities of sorghum feedstock are not available to most corn ethanol plants, including those in the northern Great Plains that were built to serve the California market. Although the yields from converting grain sorghum to ethanol can be similar to corn, the yields of sorghum per acre are lower, making sorghum a generally less desirable crop than corn for fertile or irrigated land. Sorghum tends to be grown where the land is too marginal to support a profitable corn crop, or where moisture availability is scarce. As was the case with the fuel-grade ethanol industry prior to the implementation of the LCFS regulation, grain producers will grow crops that make the most profitable use of their land and agricultural inputs.

sell to ethanol plants, but also to other customers, on the best possible commercial terms for the farmers.

LCFS 46-166 cont.

9. As indicated above, the lowest CI value for any Midwest corn ethanol pathway is 73.21 gCO_2eq/MJ and the direct CI value for that pathway is 43.21 gCO_2eq/MJ. Assuming that this lowest CI corn ethanol is blended with a gasoline blendstock assigned a carbon intensity value of 95.86 gCO_2eq/MJ (which is the value assigned to an "average" gasoline blend), LCFS compliance could only be achieved with a 15% ethanol blend ("E15") through 2015. In order for LCFS compliance to be achieved with E15 in 2016, the CI of Midwest corn ethanol would have to be reduced to 64.20, and the direct CI value to 34.20. This represents approximately a 21% reduction in the direct CI value from the lowest CI value currently documented. That same ethanol blended at 15% into the same gasoline feedstock would begin to generate deficits for the blender starting in 2017.

LCFS 46-167

10. Experience in 2011 has shown that gasoline blenders in California will quickly try to stop buying and blending ethanol that does not generate a credit against the requirements of the LCFS regulation.[5] Given the "indirect" emissions factor automatically assigned to all corn ethanol plants, and the compliance schedule for LCFS regulation in the near term, even the most efficient Midwest corn ethanol plant currently recognized by the CARB staff would need to reduce

LCFS 46-168

[5] *See* Declaration of James M. Lyons ¶¶ 5-7 .

its direct carbon intensity factor by more than 21% and file the necessary documentation with CARB, in order to continue in the California fuel market for one more year past the current limit of 2015. The costs incurred to reduce the carbon intensity of ethanol from the plant would have to be recovered by the end of 2016 before the gasoline blenders stopped buying that plant's ethanol and moved to an alternative fuel with a lower carbon-intensity level, for example, from Brazil or through the use of the "electricity" pathways in the LCFS regulation.

LCFS 46-168 cont.

11. The upshot is that even a very efficient Midwest corn ethanol plant would have to find and implement further efficiencies or energy reduction opportunities not driven by the nationwide market and recover the costs of the necessary changes, over a very short time frame. That is not commercially practicable for corn ethanol plants managed by POET LLC or, I believe, for competitor corn ethanol plants. Rather than incur those costs, U.S. corn ethanol plants will try to compete in markets outside California.

LCFS 46-169

12. In sum, I am aware of no evidence that the LCFS regulation has had any significant impact on the level of GHG emissions from corn ethanol plants located in the Midwest. A stay of the preliminary injunction will not cause the corn ethanol plants managed by POET LLC, or any competitors to those plants with whose operations I am familiar, to reduce the GHG emissions from their

LCFS 46-170

operations relative to current levels. A stay of the preliminary injunction issued by the District Court therefore will not restore or continue any GHG emissions reductions during the pendency of this litigation, simply because the LCFS regulation itself has had no effect on GHG emissions attributable to corn ethanol production, nor would it have any such effect in the near term.

LCFS 46-170 cont.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct. Executed on March 1, 2012 at Sioux Falls, South Dakota.

Erin Heupel, P.E.

Nos. 12-15131, 12-15135

UNITED STATES COURT OF APPEALS FOR THE NINTH CIRCUIT

ROCKY MOUNTAIN FARMERS UNION, *et al.*, Plaintiffs-Appellees,

v.

JAMES N. GOLDSTENE, *et al.*, Defendants-Appellants, and ENVIRONMENTAL DEFENSE FUND, *et al.*, Intervenor-Defendants-Appellants.

Appeal from the United States District Court for the Eastern District of California (D.C. Nos. 1:09-cv-02234-LJO-GSA, 1:10-cv-0013-LJO-DLB)

DECLARATION OF ROBERT WHITEMAN

I, Robert Whiteman, declare and state as follows:

1. I am the Chief Financial Officer of POET Ethanol Products, LLC, d/b/a POET Ethanol Products (hereinafter "POET Ethanol Products"), a company based in Wichita, Kansas, that markets ethanol. I provide this declaration in support of the opposition by Plaintiffs-Appellees ("Plaintiffs") to the motion filed by Defendants-Appellants ("Defendants") to stay the preliminary injunction and judgments in *Rocky Mountain Farmers Union, et al. v. Goldstene*, Case No. 1:09-

cv-02234-LJO-GSA (E.D. Cal., Dec. 29, 2011).[1] I am willing and able to present under oath the facts set forth in this declaration if called as a witness before the Court.

Summary

2. In their stay motion, Defendants claim that the low-carbon fuel standard ("LCFS") regulation has had no adverse impact on what Defendants call the "domestic ethanol industry." (Stay Mot. at 31.) As explained below in the main portion of this Declaration, the U.S. corn ethanol "industry" is compromised of numerous separately-owned corn ethanol production plants, mainly located outside California near the sources of corn used to make ethanol. Long before adoption of the LCFS regulation, investors built ethanol plants in the western Great Plains area of the Midwest to serve the California market. They did so in order to obtain the "California premium" - higher prices that prevailed for corn ethanol in California, compared to other large U.S. markets, resulting from specific economic conditions in California. (*See* ¶¶ __-__ below.) The principal impact of the LCFS regulation within what Defendants define as the "domestic ethanol industry" has fallen on those Midwest producers, who served the California market before the LCFS was adopted.

[1] *See* Motion for A Stay of the District Court's Orders and Judgments Pending Appeal (Dkt Entry 22-1) ("Stay Mot.").

3. In its first year of implementation, the LCFS regulation forced the exit from the California market of some of those Midwest corn ethanol plants that had been built to serve California. The LCFS regulation also curtailed sales of corn ethanol by some other Midwest plants that had previously had significant sales of ethanol in California. (*See* ¶¶ __-__ below.) The preliminary injunction gives all corn ethanol producers the ability to try to compete again in California as they could before the LCFS regulation took effect.[2]

4. Defendants also claim that the preliminary injunction is jeopardizing reductions in greenhouse gas ("GHG") emissions that were being provided by the LCFS regulation, or that would be provided by the regulation during the pendency of the litigation. (*See, e.g.*, Stay Mot. at 28.) That claim ignores the fact that in 2011, and currently and for the foreseeable future, corn ethanol that cannot be sold in California as a result of the LCFS is still being produced and is being sold in other markets. (*See* ¶¶ __-__ below.) The preliminary injunction is not jeopardizing reductions in GHG emissions from the corn ethanol production sector, because there is no evidence that such reductions occurred as a result of the LCFS regulation. Indeed, the LCFS regulation did not affect, and in the near term will

LCFS 46-171

[2] The exclusion of some producers from the California market and those producers' loss of the "California premium" does not mean that the LCFS regulation has lowered ethanol prices in California. *See* ¶ __ below.

not affect, methods of production or output of that sector, which are determined by macroeconomic factors unaffected by the regulation.

LCFS 46-171 cont.

5. This declaration is based on my personal knowledge of the ethanol industry gained in the course of my employment at POET Ethanol Products. I have worked in the transportation fuels industry for more than 17 years, and in the corn ethanol marketing business for more than a decade.[3] My duties at POET Ethanol Products require me to have direct, first-hand knowledge of sales of ethanol by all the production facilities for which we market ethanol. My duties also require me to have a full and current understanding of the methods of ethanol production and delivery throughout the U.S. corn ethanol industry, as well as corn ethanol marketing practices and factors affecting competitive conditions within the

[3] POET Ethanol Products currently markets ethanol from 35 ethanol producers, located in Colorado, South Dakota, Nebraska, Kansas, Missouri, Iowa, Minnesota, Indiana, Ohio, and Michigan.

Some of the ethanol plants for which POET Ethanol Products markets ethanol have management contracts with POET LLC, an ethanol plant construction and management firm based in Sioux Falls, South Dakota. The U.S. Environmental Protection Agency has sometimes referred to "POET Biorefining" as a single ethanol production or marketing entity. (*See*, *e.g.*, Renewable Fuels Standard Program (RFS2) Regulatory Impact Analysis (Feb. 2010) 97, *available at* http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1006DXP.txt. In point of fact, nearly every ethanol plant having management contracts with POET LLC is owned by a separate group of investors, which typically include a large number of investors from the farming communities near the ethanol plant, who often sell their grain to the local plant managed by POET LLC to make ethanol.

corn ethanol industry, including the impact of regulations like the LCFS regulation on corn ethanol markets.

6. The balance of my declaration is divided into two parts. Part I provides necessary background on the U.S. corn ethanol industry and the California corn ethanol market. Part II explains how the LCFS regulation affected the U.S. corn ethanol industry in 2011, and would continue to affect that industry in the absence of a preliminary injunction.

I. The Corn Ethanol Industry and the California Energy Market

7. Ethanol is used as an additive in gasoline. It has high octane ratings, and can also be used as an oxygenate to help reduce automotive air pollution. Corn ethanol produced at plants located in the Midwest historically provided about 95 percent of California's requirements for oxygenates for blending into gasoline.

8. All ethanol sold in the United States for use in motor fuel has the same physical and chemical composition, regardless of the method of production or the material from which the ethanol is produced (called the "feedstock").[4] Prior to implementation of the LCFS regulation, ethanol for use in gasoline could be sold as a fungible commodity. The market for corn ethanol for use in gasoline was highly competitive. A successful business plan for a corn ethanol plant required

[4] In the case of ethanol made from corn starch, the type of corn used is "No. 2" corn, the hard corn grown as animal feed, and not so-called "sweet corn" sold in grocery stores for human consumption.

proximity to the corn feedstock, access to competitively priced energy needed in the production process, efficient production technology and methods, and good transport logistics to get the ethanol from the plant to the customers' locations.

9. Transport logistics are particularly important for corn ethanol plants that intend to serve distant energy markets, sometimes located more than a thousand miles from the plant. Plants that produce ethanol for shipment over long distances use railways as a mode of transport, preferably in dedicated "unit trains" of tanker cars that can be loaded at sidings within or adjacent to the ethanol plant's fence line.[5]

10. California is the single largest state market for corn ethanol in the United States, historically consuming about ten percent of total U.S. corn ethanol production. Companies that market gasoline in California blend ethanol into base gasoline, called "California Reformulated Gasoline Blendstock for Oxygenate Blending," or "CARBOB." Publicly available price data show that historically, the California gasoline blenders have paid higher prices on average than could be obtained for ethanol sold in other parts of the United States. While many factors can affect the price paid for ethanol, one factor that likely accounts for the higher prices available in California is that the refineries that produce CARBOB tend to

[5] A photograph showing the integration of an ethanol plant with its rail connection is attached as Exhibit 1 to the Declaration of Russ Newman, being filed today by Plaintiffs. (*See* [ECF #], Exh. 1.)

have higher average total production costs than refineries outside California. Even after accounting for the costs of shipping ethanol over the Rocky Mountains, Midwest ethanol producers who could obtain a customer base in California obtained over time a higher "net-back" per gallon (*i.e.*, price per gallon to the customer, net of freight costs) than they could obtain in other markets. For example, in the three years prior to implementation of the LCFS regulation at the end of 2010, for example, the average California "net-back" price for a gallon of ethanol was 3.65 cents per gallon ("cpg") higher than the Chicago market, and 4.17 cpg over prices at New York Harbor.[6]

11. To compete in the California ethanol market, investors in Midwest corn ethanol plants have for many years sited their plants in locations with the best possible rail access to California. Those producers are located west of the Mississippi River, often in North and South Dakota, Minnesota, Iowa, Kansas and Nebraska. Their plants are designed at the outset to be "single line" shippers to California, meaning that they can ship their product on either the BNSF or Union Pacific systems, without changing freight lines and having to pay more than one freight bill.

[6] Based on Platts Fuel Price Service daily reports, Jan. 1, 2008 to Dec. 31, 2010, for Chicago spot prices, New York Harbor 5- to 15-day barge prices, and Southern California rail prices, less average estimates of freight from the Midwest.

II. Impacts of the LCFS Regulation

12. The basic features of the LCFS regulation, as it existed in the summer of 2010 prior to implementation, were described in the District Court's decision denying Defendants' motion to dismiss this case. (*See Rocky Mountain Farmers Union, et al. v. Goldstene*, 719 F.Supp. 2d 1170, 1177-79 (E.D. Cal. 2010).) As first adopted, and in its current form, the LCFS regulation assigns to each gallon of ethanol sold in California a "carbon intensity" (or "CI") score based on the "pathway" assigned to the plant where it is produced. The "pathway" for ethanol is in turn defined by the location where the ethanol is produced, the feedstock used (in the case of corn ethanol, No. 2 Corn), the production method, the consumption of ethanol in a vehicle's engine, and other factors. Carbon intensity is quantified in units of grams of carbon-dioxide-equivalent emissions per megajoule ("g/mj") of energy that the LCFS regulation attributes to each pathway. (*See* 719 F.Supp. 2d at 1178-79, 1197.)

13. The stated goal of the LCFS regulation is to produce reductions in the average carbon intensity of transportation fuels sold at the retail level in California, on a year-by-year basis, starting in 2011, until 2020 when that average carbon intensity is required to be 10 percent lower than before the regulation took effect. For example, the LCFS regulation's carbon intensity reduction schedule for gasoline calls for an average carbon intensity in 2011 of 95.61 g/mj (a reduction of

0.25 percent from a 2006 baseline); by 2020, the average carbon intensity level must be 86.27 g/mj. (10 percent below the 2006 baseline). A gasoline blender achieving a lower level of average carbon intensity than 95.61 g/mj in 2011 would generate a credit against the compliance schedule set by the regulation. A gasoline blender whose blended product exceeded 95.61 g/mj in 2011 would generate a deficit. LCFS credits have an indefinite lifetime. Deficits, however, must be made up by the end of the year following the year in which they were created.

14. From a marketing perspective, the simplest example of how the LCFS regulation works is to start with the fact that the LCFS regulation assigns a CI value of 95.85 g/mj for a baseline gasoline and a CI value of 95.86 to CARBOB. In 2011, the LCFS regulation set a target for the average CI of finished gasoline products at 95.61 g/mj -- a value that is 0.25% lower than the baseline gasoline CI value. An oil company blending CARBOB with ethanol having a CI value greater than 95.86 g/mj would increase, not decrease, the carbon intensity of the final gasoline product it is selling -- which is not what the regulation is trying to accomplish. As such, it would generate a deficit, rather than a credit. For ethanol assigned a CI value lower than 95.86 g/mj, the ethanol product will enable, to some extent, a reduction in the carbon intensity of the final, blended gasoline product. The lower the CI value assigned to a given ethanol pathway, the more valuable the

ethanol is to a gasoline blender trying to reduce the carbon intensity of its final product.[7]

15. As first approved by CARB in 2009, the LCFS regulation assigned a CI value of 98.40 g/mj to the Midwest corn ethanol pathway that represented the majority of Midwest plants, including most members of Growth Energy, one of the Plaintiffs in this action. An oil company blending ethanol from that most typical Midwest pathway would therefore have increased, not reduced, the carbon intensity of its finished gasoline product. At POET Ethanol Products, we saw a shift in the buying preferences of our California customers after the LCFS regulation was adopted. A number of our customers would pay a higher price for ethanol that had lower CI values, and to the extent they would buy ethanol with CI values above the CI level assigned to CARBOB, they would only purchase the ethanol at lower prices. That fact is borne out in one of the Declarations signed by Mr. Michael Waugh and filed in support of Defendants' stay motion, which states that "[w]ith the exception of a few isolated days, spot prices for ethanol with a

[7] Federal regulations limit the maximum amount of ethanol that can be blended into gasoline, and commercial gasoline blenders do not always decide to blend the highest levels of ethanol allowed by law. At a blend level of 10 percent, as explained in an accompanying declaration, the blended gasoline could not begin to generate any credit for a gasoline blender against the LCFS regulation in 2011 unless it was assigned a CI value below 95.61 g/mj. *See* Declaration of James M. Lyons ¶ __.

carbon intensity value of 90.1 [g/mj.] were at least $0.01/gal higher than with a carbon intensity of 98.4 [g/mj.], during all of 2011."[8]

16. As Mr. Waugh also notes, a number of Midwest corn ethanol producers were able to obtain adjustments in the CI levels assigned to their ethanol, after the LCFS regulation was first approved. (*See* Waugh Decl. ¶¶ 52-59.) Thus, some plants whose ethanol would have been assigned the 98.4 g/mj. carbon intensity level under the original, 2009 version of the LCFS regulation have been able to obtain lower pathways. As explained in an accompanying Declaration, those plants obtained their specific lower carbon intensity pathways by documenting the production technologies, processes, methods, and energy inputs that were already in place and which they would have used in the absence of the LCFS regulation, which the CARB staff then decided would warrant a lower-CI pathway.[9]

17. Neither Mr. Waugh nor any of Defendants' other declarants addresses the fact that, while some Midwest producers were able to provide documentation to

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[8] Declaration of Michael Waugh in Support of Defendants and Defendant-Intervenors' Motion to Stay Preliminary Injunction and Judgments Pending Appeal (Dkt Entry 21-7) ("Waugh Decl.") ¶ 46. Mr. Waugh calls the higher price for lower-CI ethanol a "price premium." *Id*. at 12:19. That higher price for some lower-CI ethanol is not the same as the "California premium" that obtained before the adoption of the LCFS regulation and that is described in Part I of my Declaration.

[9] *See* Declaration of Erin Heupel ¶¶ 5-6.

CARB showing that their ethanol should not be penalized in 2011 with a CI value higher than gasoline, other Midwest plants were unable to do so. Some of the plants that could not document the production technologies, processes, methods, and energy inputs that the CARB staff would reward with lower CI values had previously sold a substantial volume of ethanol in California. The LCFS regulation forced some of those plants entirely out of the California market in 2011. Several of those plants have come forward in this proceeding, and have provided Plaintiffs with declarations that explain the impact of the LCFS regulation on their business.[10]

LCFS 46-172

18. The effect of the LCFS regulation has been to "de-commoditize" the corn ethanol market, for purposes of California -- *i.e.*, ethanol is no longer a fully fungible commodity in California, in which producers can prevail by offering the best commercial terms. Plants that were optimized for shipment of ethanol to California when they were built, but that can no longer sell their ethanol in California, now must find buyers outside California. On an industry-wide basis, the LCFS regulation has led to "fuel shuffling" that has likely increased the number of miles that Midwest corn ethanol had to travel in 2011 in order to get from the production facilities to customer destinations.

LCFS 46-173

[10] *See* Declaration of Duane Kristensen (impact of LCFS regulation on Nebraska corn ethanol producer); Declaration of Russ Newman (impact on North Dakota producer); Declaration of Delton Strasser (on South Dakota producer).

19. Some of the Midwest plants that were excluded from the California market in 2011, especially those built to serve California, have been required to ship their product using multiple-stage freight movements, which increased the costs of delivery to the customers. Those plants have lost the ability to compete for the lucrative California market, and have also been required to incur higher costs to sell at lower prices elsewhere, as their logistics for delivery have become more complex. Defendants ignore those impacts on the producers who have been excluded from California. The preliminary injunction issued by the District Court is essential to efforts by those producers to try to re-enter the California market and to compete for sales.

LCFS 46-174

20. For all the disruptions in the California ethanol market created by the LCFS regulation, there has been no reduction in the overall amount of corn ethanol produced in the United States, or used as a motor fuel in this country or overseas. (As Mr. Waugh notes, U.S. ethanol producers have recently been shipping some ethanol overseas.) The overall production levels for corn ethanol last year, and for the foreseeable future, depend on macroeconomic factors (including demand for gasoline) that are independent of the LCFS regulation.

21. In conclusion, although Defendants claim that the "LCFS was expected to result in emissions reductions [in California] of almost one million metric tons (MTs) in 2012 and almost two million in 2013," and that "[t]hose

LCFS 46-175

targets would be achieved with a stay" of the preliminary injunction" (Stay Mot. at 28), those claims have no basis in fact. The same amount of corn ethanol would have been produced in the United States in 2011 in the absence of the LCFS regulation, and renewed enforcement of the LCFS regulation cannot be predicted to have any impact on national production of corn ethanol during the pendency of this litigation. The only effect of the LCFS is to cause ethanol "shuffling" by which some lower CI corn ethanol that would have been sold elsewhere is instead shipped to California while the higher CI corn ethanol that would have otherwise been sold in California is sold elsewhere.

LCFS 46-175 cont.

22. Finally, I note that Defendants' claim that any GHG emissions that occurred in 2011 "will be lost" in the absence of a stay. (*Id*.) Buyers in the California ethanol market typically purchase their requirements in multi-month, forward contracts. Even if one were to credit Defendants' claim (which is incorrect, for the reasons explained above) that the LCFS regulation affected production of ethanol in 2011 in a way that reduced GHG emissions, the preliminary injunction issued by the District Court on December 29, 2011, has had no impact on ethanol delivered in California under those contracts..

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct. Executed on March 1, 2012 at Wichita, Kansas.

_____

Robert Whiteman

17_OP_ADF_GE Responses (Page 155 – 179)

104. Comment: **LCFS 46-164 through LCFS 46-175**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Regulation Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

Appendix F

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October 31, 2014

By Electronic and U.S. Mail

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Chief Economist
California Department of Finance
915 L Street
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Stephen Adams, Esquire
William Brieger, Esquire
California Air Resources Board
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Re: Standardized Regulatory Impact Assessments for the Low-Carbon Fuel Standard and Alternative Diesel Fuel Rulemakings

Dear Dr. Asmundson and Messrs. Adams and Brieger:

Thank you for providing public access to the combined standardized regulatory impact assessments (the "CSRIA") for the low-carbon fuel standard ("LCFS") and alternative diesel fuel ("ADF") rulemakings. I write in order to present some specific questions based on Growth Energy's review of the CSRIA. The first set of questions are intended for the ARB Chief Counsel's Office, and the second set are intended for both the Department of Finance and the ARB Chief Counsel's Office. Let me state at the outset that Growth Energy appreciates the opportunity to participate in the SB 617 process for these two important rulemakings, and the consideration that the ARB staff has given to its submittals. Growth Energy regrets that more information about the goals and the estimated benefits or costs of the LCFS and ADF proposals was not available to stakeholders prior to the time when alternative proposals had to be submitted.

1. Evaluation of ADF Alternatives

Based on some recently-received information (*see* Attachment A), it appears that the ADF portion of the CSRIA does not present ARB's currently proposed regulatory approach to mitigate emissions increases that would be caused by the use of biodiesel fuels in order to comply with the LCFS regulation. As Mr. Adams confirms in Attachment A, ARB does not plan to require mitigation for any biodiesel blends below five percent ("B5"). This is contrary to what the CSRIA describes as ARB's proposal for the ADF regulation, which would require mitigation for some biodiesel blends at concentrations greater than one percent. (*See* CSRIA at 4.) Growth Energy appreciates Mr. Adams' prompt clarification of what the ARB staff is currently planning to consider as part of the ADF regulation.

In light of this clarification, Growth Energy would like to inquire whether the ARB staff plans to revise the portion of the CSRIA that discusses Growth Energy's proposed alternative to the ARB

ADF 17-15

proposal. The CSRIA states at one point that the Growth Energy alternative "may achieve more emissions benefits" than ARB's proposal under some circumstances (CSRIA at 22), but then later states that the Growth Energy alternative "does not result in any more emissions reductions than the ADF proposal." (*Id.*) Those two statements appear to contradict one another.

ADF 17-15 cont.

The threshold question is whether the ARB staff intended to state that the Growth Energy proposal would, or would not, result in greater emissions reductions than the ARB proposal (as now clarified). The first quoted portion of the CSRIA refers to possible emissions reduction benefits under the Growth Energy proposal "if biodiesel were to be widely used as an additive under the ADF proposal." (CSRIA at 22.) Based on the ARB staff's projections (and treating biodiesel as "an additive"), biodiesel will certainly be "widely" used in many parts of the State and for many years. If the ARB staff disagrees, or if it meant something different when referring to the use of biodiesel as an "additive," please explain the reason for disagreeing, or clarify what "additive" means in this context.

ADF 17-16

The next question assumes that ARB did, in fact, intend to acknowledge that the Growth Energy proposal would be more protective -- provide more emissions reductions -- than the ARB proposal. On that premise, please advise whether ARB intends to revisit its position that the Growth Energy proposal would only provide "marginally more emissions benefits" than the ARB proposal, now that it is clear that ARB proposes not to require mitigation of any biodiesel blends below B5. In order for Growth Energy and others, including the Department of Finance, to understand the amount of incremental benefit that ARB would assign to the Growth Energy proposal, please also indicate how the staff has quantified that increment, and provide the inputs and assumptions on which that quantification is based.

ADF 17-17

2. Evaluation of LCFS Alternatives

The CSRIA appears to treat Growth Energy's proposed alternative to the LCFS proposal as not requiring complete assessment under the governing statute and regulations. Thus, referring to Growth Energy's proposed alternative ("this alternative") and to the CSRIA itself ("this document"), Appendix A of the CSRIA states as follows:

> ARB is required to analyze only those alternatives that are reasonable and that meet the goals of the program as required by statute. An initial assessment of the program indicates the goals of the LCFS proposal can be achieved by keeping the program '...separate of the AB 32 Cap-and-Trade system initially (at least first 10 years) in order to stimulate innovation and investment in low-GWI [global warming intensity] fuel (or transportation) technologies.' Due to the strong justifications that the Cap-and-Trade program alone generates neither the CI reductions nor fuel in the transportation sector, ***this alternative will not be assessed in this document.***

CSRIA at 27 (footnote omitted; emphasis added). The CSRIA concedes that Growth Energy's proposed alternative would "likely" achieve the same "estimated GHG emissions reductions" as the current regulation in the period up to 2020. (*Id.* at 26-27.)

LCFS 46-176

The deficiency in the Growth Energy proposal, according to the CSRIA, is not that it creates a GHG emissions reduction shortfall at any point prior to the end of the current regulatory horizon; instead, the problem is that the Growth Energy proposal does not rely on the same strategy of fuels diversification

LCFS 46-177

and achievement of GHG emissions reductions as proposed by ARB. As Appendix A of the CSRIA explains:

> Transportation in California was powered almost completely by petroleum fuels in 2010. ... Transitioning California to alternative, lower-carbon fuels requires a very focused and sustained regulatory program tailored to that goal. ... In the absence of such a program, post-2020 emissions reductions would have to come from a transportation sector that would, in all likelihood, have emerged from the 2010-2020 decade relatively unchanged. ***In the absence of an LCFS designed to begin the process of transitioning the California transportation sector to lower-carbon fuels starting in 2010, post-2020 reductions would be difficult and costly to achieve.*** This is why the primary goals of the LCFS are to reduce the carbon intensity of California fuels, and to diversify the fuel pool. A transportation sector that achieves these goals by 2020 will be much better positioned to achieve significant GHG emissions reductions post-2020.

LCFS 46-177 cont.

CSRIA at 27 (emphasis added). In essence, the CSRIA is claiming that fuels diversification and carbon intensity requirements are necessary in order to make post-2020 greenhouse gas reductions less costly and less difficult to achieve. Growth Energy would submit, with the greatest respect, that the stated rationale for not providing a complete assessment of its alternative is itself deficient.[1] These are the salient points:

LCFS 46-178

- The LCFS regulation does not require, and based on ARB publications is not expected to result in, the production or use of any type of alternative fuel that other regulations do not already either require or cause to be used in California. The federal renewable fuels program is intended to provide for the production and sale of cellulosic and "advanced" biofuels in the same time frame as the LCFS regulation. While the federal program does not require the use of electricity or hydrogen as a transportation fuel, the California motor vehicle emissions control and zero-emission vehicle programs do.[2]

LCFS 46-179

- The long-run, post-2020 plans for greenhouse gas reductions developed by ARB calls for the phase-out of reliance on liquid biofuels.[3] Eventually, the State plans to eliminate gasoline, in

LCFS 46-180

[1] Elsewhere, the CSRIA states that a goal of the LCFS regulation is to "create a durable regulatory framework that can be adopted by other jurisdictions." (CSRIA at 2.) ARB's authorizing legislation directs and permits the Board to adopt regulations to reduce greenhouse gas emissions. The statute does not permit the Board to impose costs on California consumers and businesses in order to export regulations to "other jurisdictions." Notably, the CSRIA does not try to claim that adoption of the LCFS program outside California will reduce costs. To the contrary, adoption of the LCFS program in other jurisdctions is likely to create supply shortages for the lowest-carbon-intensity alternative fuels, and could increase compliance costs for California consumers and businesses.

LCFS 46-178 cont.

[2] *See* Attachment B (Growth Energy's proposed alternative to the LCFS regulation) at 8-11 (describing programs that will achieve the fuels diversification sought by ARB, in the absence of the LCFS regulation).

LCFS 46-179 cont.

[3] *See* http://www.arb.ca.gov/planning/vision/vision.htm.

particular, from use in California cars and trucks and fully to replace gasoline with electricity. Putting to the side whether ARB's post-2020 strategy is meritorious, the CSRIA does not explain why ARB would seek to impose costs on California consumers and businesses to foster the use of fuels that (according to ARB) are destined for a diminishing, and no long-term, role in its greenhouse gas reduction strategy.

LCFS 46-180 cont.

- ARB's authorizing legislation does not itself require the use of regulations intended to reduce the carbon intensity of transportation fuels to achieve greenhouse gas reduction; it requires that enacted regulations achieve "the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions."[4] If the CSRIA's premise is that regulation of the carbon-intensity of transportation fuels is necessary now in order to reduce the costs or difficulties of achieving greenhouse gas reductions after 2020, as the State transitions away from biofuels, then the CSRIA should have included (i) an identification of the desired reductions in greenhouse gas emissions in the transitional period, and (ii) a sufficient explanation of why the costs of achieving those reductions would be reduced if Californians paid now for compliance with an otherwise unnecessary regulatory program. On a net-present value basis, there is reason to doubt that reliance on the LCFS regulation up to 2020 is the most cost-effective way of reducing greenhouse gas emissions after 2020 -- particularly when ARB would still have authority under its authorizing legislation to adopt and enforce regulations requiring reductions in the carbon-intensity of transportation fuels after 2020.

LCFS 46-181

Appendix A of the CSRIA therefore uses unsupported speculation about future regulatory costs and strategies, and an unspecified target for a future regulation (a regulation to reduce greenhouse gas emissions resulting from the use of liquid biofuels after 2020), as reasons to not provide a complete assessment of the Growth Energy alternative. The question presented is whether the CSRIA is substantially compliant with the Government Code, as amended by SB 617, and with the Department of Finance's implementing regulations.

Section 11346.36 of the Government Code provides that standardized regulatory impact assessments must compare

> [P]roposed regulatory alternatives with an established baseline so agencies can make analytical decisions for the adoption, amendment, or repeal of regulations necessary to determine that the proposed action is the most effective, or equally effective and less burdensome, alternative in carrying out the purpose for which the action is proposed, or the most cost-effective alternative to the economy and to affected private persons that would be equally effective in implementing the statutory policy or other provision of law.

Cal. Gov't Code § 11346.36(b)(2). The Department of Finance's SRIA regulations accordingly require among other things that agencies "should consider" including in their analyses the "assumptions" and "data" used in the evaluation of regulatory alternatives and use "an established baseline" in evaluating "feasible alternatives" to a regulatory proposal. 1 C.C.R. §§ 2003(e), (e)(5). In addition, another portion

LCFS 46-182

[4] Cal. Health & Safety Code § 38562(a).

of those regulations requires agencies to consider "how the effects of the regulation are distributed over time," including costs and benefits. *Id.* at § 2003(e)(4). LCFS 46-182 cont.

The Department's regulations do not specifically provide that agencies may exclude some proposed alternatives from stakeholders from complete analysis. Whether or not the discussion of Growth Energy's proposed alternative to the LCFS proposal in Appendix A is considered as complete as the evaluation of the regulatory alternatives considered in the main text of the CSRIA, ARB's rejection of Growth Energy's alternative does not meet the requirements of the Government Code, as amended by SB 617. LCFS 46-183

The CSRIA concedes that Growth Energy's alternative is likely to achieve the same level of greenhouse gas emissions reductions as the ARB proposal within the time frame for specific emissions reductions (2010-2020) defined by the ARB proposal. The CSRIA does not identify a single alternative fuel that other regulations will not require to be produced and used in California. (*See* note 2 above.) The questions that ARB was therefore required to address are whether the Growth Energy alternative is (i) "equally effective and less burdensome in carrying out the purpose for which the action is proposed," and (ii) would be "the more cost-effective alternative." Cal. Gov't Code § 11346.36(b)(2). ARB's negative answer to those two questions posed in the statute depends on its unsupported notions about how the use of carbon intensity regulations now will ease and reduce the costs of greenhouse gas reductions after 2020. ARB has provided the Department with no basis on which to evaluate, much less to credit, its belief that imposition of the regulatory costs of the LCFS program now will reduce the costs of post-2020 greenhouse gas reductions. Without more, there is no basis to conclude that the ARB proposal is more cost-effective than the Growth Energy alternative. LCFS 46-184

The enactment of SB 617 requires ARB to employ a level of analytical rigor and transparency in the current rulemaking that may not have been required in 2009, when the Board embarked on the regulation of carbon intensity. Likewise, SB 617 requires the Department of Finance to ensure that agencies meet the requirements of SB 617, including what is now section 11346.36 of the Government Code. ARB may contend that the requirements of sections 2002 and 2003 in the Department's regulations are merely precatory, because, for example, section 2003 only lists what an agency "should" consider in the analytical process. That is a question for the Department to consider, as indicated below; regardless, under the text of the Government Code, either the CSRIA does not meet the requirements of the Department's regulations, or those regulations are themselves deficient. LCFS 46-185

Growth Energy therefore suggests that the Department of Finance and the ARB Chief Counsel's Office consider and respond independently to the following questions:

- Whether the requirements for regulatory analysis contained in sections 2002 and 2003 of the Department's regulations are mandatory for all major rulemakings; LCFS 46-186
- Whether the Department's regulations allow an agency to engage in two different levels of review and consideration of regulatory alternatives, in the manner apparently pursued by ARB in the LCFS and ADF rulemakings; LCFS 46-187
- Whether the Department has the authority, or the duty, to refuse to comment upon, or otherwise reject, a standardized regulatory impact analysis that does not contain the information and analysis required by sections 2002 and 2003 of its regulations; LCFS 46-188

- Whether the CSRIA's reliance on speculative and unquantified future (post-2020) estimated cost savings meets the requirements of SB 617 and the Department's regulations, particularly the portions of those regulations that require adequate definition of a baseline, comparative cost-effectiveness assessments, a discussion of "uncertainties associated with … estimates," and attention to how the effects of a regulation (both costs and benefits) may differ in their timing. *See* 1 C.C.R. § 2003(e), (e)(3), (e)(3)(D), (e)(4), (e)(5); and LCFS 46-189
- If the CSRIA meets the requirements of the Department's current regulations, whether those regulations should be amended in order to more effectively permit the evaluation of alternatives required inter alia by section 11346.36(b)(2) of the Government Code. LCFS 46-190

Thank you again for allowing Growth Energy to participate in the SB 617 process for these two regulations. I would appreciate it if you would advise me whether and how the Department and the ARB Chief Counsel's Office plan to respond to the specific questions presented in this letter. In addition, please let me know if you would like to discuss the issues raised here, including the questions that Growth Energy hopes you will consider and address.

Sincerely,



David Bearden
General Counsel and Secretary

cc: Mr. Michael Waugh (by electronic mail)
Mark W. Poole, Esquire (by electronic mail)
Elaine Meckenstock, Esquire (by electronic mail)

17_OP_ADF_GE Responses (Page 180 – 186)

105. Comment: **LCFS 46-176 through LCFS 46-190**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

106. Comment: **ADF 17-15 Chantel**
The comment requests clarification as to whether ARB will update the portion of SRIA that discusses the Growth Energy alternative in light of new information submitted with the comment letter.

Agency Response:
ARB does not intend to update the SRIA. The combined LCFS/ADF SRIA analyzes the GE alternative as required by SB 617 and the implementing regulations. The SRIA states that the GE alternative "may achieve marginally more emissions benefits if biodiesel were to be widely used as an additive" but that under the current conditions "the GE alternative does not result in any more emissions reductions" and is unnecessarily strict and costly. As a clarification, when saying "widely used" staff was referring to if biodiesel were to be used in volumes much higher than in the compliance scenarios , and use of the term additive was used in the colloquial sense as biodiesel is "added" to diesel and is functionally equivalent to the term "blend" in this case. Additionally, ARB staff projections are cited on page E-36 of the ADF Staff Report.

107. Comment: **ADF 17-16 Chantel**
The comment questions specific phrasing used in the LCFS/ADF SRIA.

Agency Response:
See response **ADF 17-15**.

108. Comment: **ADF 17-17**
The comment requests clarification on how the GE alternative incremental benefits were determined.

Agency Response:
Please see the GE alternative discussion in response **ADF 17-10.**

Attachment A

Drake, Stuart

From: Adams, Stephen@ARB <Stephen.Adams@arb.ca.gov>
Sent: Wednesday, October 29, 2014 2:34 PM
To: majorregulations@dof.ca.gov
Cc: Drake, Stuart; Brieger, William@ARB; Elaine Meckenstock (Elaine.Meckenstock@doj.ca.gov)
Subject: FW: LCFS and ADF rulemakings -- SRIAs

To whom it may concern:

The emails below relate to the SRIA that ARB staff submitted on October 17 for the low-carbon fuel standard regulation and alternative diesel fuel regulation. This copy is being provided for your information.

Stephen Adams
ARB Senior Staff Counsel

From: Adams, Stephen@ARB
Sent: Wednesday, October 29, 2014 11:28 AM
To: 'Drake, Stuart'
Cc: Brieger, William@ARB; Elaine Meckenstock
Subject: RE: LCFS and ADF rulemakings -- SRIAs

Stuart,

The differences you point to between the biodiesel mitigation described in the SRIA and that presented at the Oct. 20 workshop reflects the progression in staff's analysis of the biodiesel NOx issue and mitigation for NOx emissions from biodiesel. You're correct that the SRIA describes a plan to require mitigation for blends from B1 and higher, while the proposal discussed at the workshop would require mitigation beginning at blends of B5 and higher. The reasons behind these changes were described at the workshop, and also on page 2 of the discussion paper that you cite.

Time constraints prevented staff from revising the SRIA to reflect staff's more recent approach. Although the SRIA was submitted to the Department of Finance on the same day that workshop materials were made available, the modeling and analysis work to prepare the SRIA was a weeks-long process. The SRIA as submitted discloses potential economic impacts from the ADF, and the economic impacts from staff's revised approach will likely be lower than stated in the SRIA. I'd also note that the issues of biodiesel NOx emissions and mitigation are still the subject of internal discussion and analysis, and consequently these provisions are subject to further changes prior to filing of the proposed regulation with the Office of Administrative Law.

The economic impact analysis for the ADF will be updated as we move forward. Regulatory concepts and proposals are often revised during their development and public review, especially at this preliminary stage. Given that, changes such as the one involving staff's evaluation of biodiesel emissions are to be expected.

Sincerely,

Steve

From: Drake, Stuart [mailto:sdrake@kirkland.com]
Sent: Tuesday, October 28, 2014 6:30 AM
To: Adams, Stephen@ARB

Cc: Brieger, William@ARB; Elaine Meckenstock
Subject: LCFS and ADF rulemakings -- SRIAs

Steve --

The Department of Finance yesterday provided Growth Energy and other members of the public with access to the October 17, 2014 SRIA that covers the ADF rulemaking. Thank you for helping to make that happen. I'd like to request your Office's further assistance with what appears to be a substantial problem in one portion of the SRIA. That is the portion of the SRIA that describes the staff's proposed mitigation strategy to the Department of Finance and others.

Page four of the SRIA describes the mitigation strategy for the staff's ADF proposal in relevant part as follows (emphasis added):

> "The multimedia evaluation process for biodiesels made from various feedstocks identified a NO_X significance threshold, or blend level, that will result in no significant adverse impacts. The ADF proposal seeks to mitigate NO_X impacts from biodiesel by setting a significance threshold and requiring mitigation of all non-animal biodiesel use at blends above one percent, and all animal biodiesel used at blends above five percent. *The ADF proposal identified one percent for non-animal biodiesel, rather than zero percent, because biodiesel may be used as an essential lubricity additive at one percent or less.*"

I am not aware that anyone has called for mitigation when there is zero percent biodiesel in the blend. Growth Energy has proposed mitigation below the five percent level (or "B5") if the blend level was one percent or greater, as the SRIA elsewhere notes. (*See* SRIA at 22.) In any event, a fair reading of the SRIA is that the ARB decided, as of October 17, to require mitigation of all non-animal biodiesel use at blends above one percent.

LCFS 46-191

I believe there may be some material confusion about the ARB staff's position. The confusion arises because the staff appears to be saying different things in its filings with the Department of Finance and in some of its public statements. Appendix A of the ADF regulatory "discussion paper" released by the ARB staff on the same day as the SRIA (October 17) describes the staff's ADF proposal as follows:

> " Recognize biodiesel made from soy feedstocks as low saturation (i.e., B100 with cetane <56) and biodiesel made from animal feedstocks as high saturation (i.e., B100 with cetane ≥56).
>
> " Establish significance thresholds of B5 for low saturation biodiesel, and B10 for high saturation biodiesel to ensure NOx impacts associated with biodiesel use do not increase and steadily decrease. Allow 'Safe Harbor' blending below the significance threshold without the need for additional NOx mitigation."

See http://www.arb.ca.gov/fuels/diesel/altdiesel/20141017_ADF_discussion_paper.pdf. That proposal (mitigation of non-animal based, aka "low saturation" biodiesel, at B5 and higher) was discussed at the ARB staff's workshop on October 20. So, in a nutshell, the SRIA indicates that mitigation will be required for non-animal biodiesel with blend levels above one percent; by contrast, the "discussion paper" and the staff's presentation to the public at its October 20 2014 workshop, indicated that mitigation would only be required for animal-based blends at or above five percent.

LCFS 46-192

If the blend level at which the staff proposal would require mitigation is material enough to have been presented in the SRIA, then this apparent inconsistency in the relevant blend level for mitigation is also material. The SRIA advises the Department of 2inance that the staff's proposal "will result in no significant adverse impacts on public health or the environment." (SRIA at 3.) The Department might reasonably believe that the SRIA's claim in that regard was based on mitigation for animal-based biodiesel blends between one and five percent, based on the portion of the SRIA appearing on page 4 that is quoted above. The likelihood that the Department will be misled -- I assume inadvertently -- about this basic element in the staff's AD2 proposal is sufficient in itself to require correction. In addition, the inconsistency is also relevant to the reasonableness of the staff's claim in the SRIA that the Growth Energy alternative proposal "does not result in any more emissions reductions than the AD2 proposal." (SRIA at 22.) Presumably, in evaluating that claim, the Department would want to know that the staff's proposal does not require mitigation for non-animal based biodiesel at the same level as does the Growth Energy proposal.

LCFS 46-193

If I am missing something that explains why the description of the staff's AD2 proposal in the SRIA does *not* differ materially from the description in the materials that the staff has released to the public on October 17, please let me know. If the staff's proposal really is to require mitigation for non-animal blends higher than one percent (even if less than five percent), please let me know. Otherwise, Growth Energy would like to know how the staff plans to correct the SRIA, so that the Department and others will have an accurate understanding of the staff's proposal.

LCFS 46-194

On the assumption that the Department has to provide its evaluation of the SRIA very soon, Growth Energy requests a response to this inquiry by the close of business on Wednesday, October 29.

Please let me know if you would like to discuss these questions, or if you don't believe that the staff will be able to respond by the close of business on October 29. Thanks, Stuart

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17_OP_ADF_GE Responses (Page 187 – 190)

109. Comment: **LCFS 46-191 through LCFS 46-194**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

Attachment B

STATE OF CALIFORNIA

AIR RESOURCES BOARD

RESPONSE TO REQUEST FOR PUBLIC INPUT ON ALTERNATIVES TO THE LOW- CARBON FUEL STANDARD REGULATION

GROWTH ENERGY

JUNE 23, 2014

Executive Summary

The staff of the California Air Resources Board ("CARB") has identified the Low-Carbon Fuel Standard ("LCFS") as a "major regulation" that requires enhanced review for compliance with SB 617 (Calderon and Pavley), a 2011 amendment to the California Administrative Procedure Act (the "APA"). The California Department of Finance ("the Department") has published regulations that implement SB 617. Those regulations require rulemaking agencies like CARB to seek early public input on possible alternatives to the rules being developed by the rulemaking agencies.

Growth Energy, an association of the Nation's leading ethanol producers and other companies that serve America's need for renewable fuels, is submitting to the CARB staff a proposed alternative to the LCFS regulation that would allow the State to eliminate the LCFS program without loss of environmental benefits. Growth Energy's proposal recognizes important changes in the regulatory baseline for the control of greenhouse gas ("GHG") emissions that have occurred since 2009. In particular, the federal renewable fuels standard ("RFS") program, combined with the California cap-and-trade program and a number of California-specific vehicle- and engine-based regulations, now assure that California will receive most if not all of the direct GHG emissions reductions that can be attributed to the LCFS regulation. To the extent that CARB believes that there is still an emissions shortfall from elimination of the LCFS or that it has authority to address lifecycle GHG emissions occurring outside of California under state and federal law (which are issues not addressed in this submittal), Growth Energy proposes that CARB address those remaining issues by modifying the California GHG cap-and-trade regulations, which are now in effect in California and which apply to transportation fuels providers beginning in 2015.

LCFS 46-195

Growth Energy's description of its proposed alternative to the LCFS regulation is as detailed as possible, given currently available information. In this submittal, Growth Energy urges the CARB staff to provide the additional information needed to provide further analysis of alternatives to the LCFS regulation.

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Growth Energy's Response to Request for Public Input
On Alternatives to the Low-Carbon Fuel Standard Regulation

Growth Energy respectfully submits this response to the request by the staff of the California Air Resources Board ("CARB") for public input on alternatives to the low-carbon fuel standard ("LCFS") regulation. The CARB staff presented its request for public comment in a notice dated May 23, 2014, and has established today as the deadline for that input.

The CARB staff is seeking public input in connection with its proposal that CARB revise and readopt the LCFS regulation at a public hearing later this year. The purpose of the LCFS regulation, which the Board first adopted in 2009, is to achieve reductions in greenhouse gas ("GHG") emissions from the California transportation sector pursuant to the Global Warming Solutions Act of 2006, commonly called AB 32. Other regulations adopted since 2008 under AB 32 to achieve the same objectives as the LCFS regulation include the "cap and trade" regulation (17 C.C.R. §§ 95801-96022), the GHG emissions standards contained in the Advanced Clean Cars (or "ACC") program (13 C.C.R. §§ 1960.1-1962.2), and a set of regulations to control GHG emissions from heavy-duty vehicles and engines.[1]

LCFS 46-196

Overview

Growth Energy has organized its analysis of alternatives to the LCFS regulation in this submission into four parts.

Part I of this submission briefly outlines the statutory and regulatory framework for the CARB staff's request for input on alternatives to the LCFS regulation. As explained in Part I, regulations adopted by the California Department of Finance pursuant to a recent amendment to the APA require CARB to seek and permit effective early public input on rulemaking concerning

[1] These include California's Heavy-Duty GHG regulations now completing the rulemaking process, a second phase of regulations that are under development, and the so-called "Tractor-Trailer" GHG regulation adopted in 2008. *See* http://www.arb.ca.gov/regact/2013/hdghg2013; http://www.arb.ca.gov/cc/hdghg/hdghg.htm.

"major" regulations, including the LCFS. That amendment was contained in SB 617 (Calderon and Pavley). The LCFS rulemaking, and this stage of the LCFS rulemaking, are particularly important, because this rulemaking is one of the first CARB rulemakings governed by SB 617. *See* pp. 4-7 below.

Part II of Growth Energy's submittal addresses some of the important factors that affect a regulatory alternatives analysis undertaken under SB 617. Since 2009, there have been significant changes in the "baseline" conditions for GHG regulation relevant to the LCFS program. As explained in Part II, most of the GHG emissions reductions sought by CARB when it adopted the LCFS regulation in 2009 will be provided by a combination of the federal renewable fuels standard ("RFS") program, along with California's cap-and-trade regulation, ACC program, and regulations limiting GHG emissions from heavy-duty vehicles and engines. Given that most, if not all, of the GHG emissions reductions sought by CARB in 2009 through the LCFS regulation are now assured by those other programs, the LCFS regulation has been rendered largely superfluous from an environmental perspective, even though it imposes huge financial burdens on the regulated community and requires a large commitment of resources by CARB. As a threshold matter, CARB should therefore carefully and fully consider whether, based on regulatory and program developments related to GHG emission control since 2009, there is any continuing need for the LCFS regulation. *See* pp. 8-14 below.

LCFS 46-196 cont.

Part III of this submittal explains that, to the extent that the CARB staff finds any continuing need for the LCFS regulation to control GHG emissions, that need could be met instead through a simple modification of the cap-and-trade regulation. Taking that step -- modifying the cap-and-trade regulation -- would fully eliminate any conceivable remaining need for the LCFS regulation, while doing nothing to alter CARB's overall regulatory strategy to

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address GHG emissions from the California transportation sector. The GHG emissions reductions benefits of the LCFS program would be fully realized from the suite of other GHG regulations adopted federally and in California since 2009, and by the modification of the cap-and-trade program. The direct regulatory costs of the LCFS program are borne primarily by the California motor vehicle fuels marketing industry, which can to some extent pass those costs to its retail customers. Insofar as the LCFS program imposes costs on California businesses and consumers, the alternative presented here (relying on the cap-and-trade program) would not materially alter the allocation of costs and would at the same time reduce regulatory costs by eliminating an entire regulatory program (the LCFS regulation). Judging from the strong concern about the LCFS regulation expressed by oil industry stakeholders, the regulatory relief and reform proposed here warrants full consideration and further development. *See* pp. 14-20 below.

LCFS 46-197 cont.

Part IV of Growth Energy's submittal recommends specific next steps that CARB should consider, including full involvement by the Chief Counsel's Office to ensure compliance with the APA. As will be apparent throughout this submittal, Growth Energy's analysis of regulatory alternatives can be no more detailed than the publicly available information about (i) the new version of the LCFS regulation that the CARB staff is considering for proposal to the Board, and (ii) the information that the CARB staff has provided about the benefits that it is attributing to the LCFS program. Contrary to the position taken in communications to Growth Energy by CARB's Transportation Fuels Section on this subject, very little information on the new version of the LCFS regulation or its estimated benefits -- which are critical to an effective SB 617 process -- has been provided to the public to date. In order to achieve substantial compliance with the APA, the CARB staff needs to provide the public with a full picture of its proposed new

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LCFS regulation, and in particular describe any new features of the regulation intended to reduce compliance costs. The CARB staff also needs to completely identify for the public all benefits that it is attributing to the LCFS regulation that would bear on an SB 617 alternatives analysis. Then, after the public has had sufficient time to analyze the relevant information from CARB, the public should be permitted to provide updated regulatory alternative analyses, which the CARB staff should fully consider and address in the Standardized Regulatory Impact Assessment required by 1 C.C.R. § 2002. That approach would ensure compliance with the APA, without conflicting or otherwise undermining any other mandates or obligations applicable to the LCFS regulation. *See* pp. 20-24 below.

LCFS 46-198 cont.

I. The Statutory Framework for the Regulatory Alternatives Analysis under SB 617

The CARB staff is seeking submittals from the public on regulatory alternatives to the LCFS regulation because it has a legal obligation to do so. For many years, section 11346.3 of the APA has provided in part as follows:

> (a) State agencies proposing to adopt, amend, or repeal any administrative regulation shall assess the potential for adverse economic impact on California business enterprises and individuals, avoiding the imposition of unnecessary or unreasonable regulations or reporting, recordkeeping, or compliance requirements. ...
>
> (2) The state agency, prior to submitting a proposal to adopt, amend, or repeal a regulation to the office, shall consider the proposal's impact on business, with consideration of industries affected including the ability of California businesses to compete with businesses in other states. For purposes of evaluating the impact on the ability of California businesses to compete with businesses in other states, an agency shall consider, but not be limited to, information supplied by interested parties.

Cal. Gov't Code § 11346.3(a)(2). Based on evidence that rulemaking agencies did not adequately consider the burdens that regulations impose on the public, in SB 617 the Legislature added a requirement that rulemaking agencies prepare a detailed assessment of the costs and benefits of any proposed major regulation, for review by the California Department of Finance

("the Department") ***before*** initiating the traditional informal rulemaking process. *See id.* § 11346.3(c). Those detailed assessments are called Standardized Regulatory Impact Assessments (or "SRIAs."). *See id.* § 11346.36. The Legislature also made it clear in SB 617 that the obligation to consider and use early public input on regulatory impacts could not be met by merely going through the formalities of seeking public input.[2]

The Department completed work on regulations to implement SB 617 in the fall of 2013. The Department's regulations require, among other steps, the following:

> The [rulemaking] agency shall also seek public input regarding alternatives from those who would be subject to or affected by the regulations ... prior to filing a notice of proposed action with OAL unless the agency is required to implement federal law and regulations which the agency has little or no discretion to vary. An agency shall document and include in the SRIA the methods by which it sought public input.

1 C.C.R. § 2001(d). As the rulemaking file for the Department's regulations implementing SB 617 shows, many state regulatory agencies, CARB not excepted, recognized that SB 617 (as implemented by the Department) would mean the end of "business as usual" in the California rulemaking process.[3]

In responding to objections from rulemaking agencies concerning the obligations created by its SB 617 regulations, the Department explained that "[i]nvolving the Department and affected parties early in the [rulemaking] process could result in the discovery of additional and

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[2] Thus, SB 617 deleted text from section 11346.3(a)(2) of the APA that, up to 2011, had provided that the APA's public-input requirements were not "inten[ded]" to "impose additional criteria on agencies" engaged in rulemaking. *See* Stats. 2011, c.496 (SB 617), subd. (a); Cal. Office of Admin. Law, *California Rulemaking Law under the Administrative Procedure Act* (2012) 57 (legislative history of section 11346.3).

[3] Several rulemaking agencies filed sharp objections to the Department's proposed regulations to implement SB 617 on the ground that the regulations would require major changes in the timing used by the agencies to develop regulations and to obtain public input. *See, e.g.,* Dep't of Finance, *Regulations to Implement SB 617 Re Major Regulations, Responses to 45-day Comment Period (Chart A)* (hereinafter "Chart A"), available at http://www.dof.ca.gov/research/economic_research_unit/SB617_regulation/documents/Response%20to%20Comments%20Chart A.pdf. The Department dealt fully with all those objections and made no material changes in its proposed regulations to implement SB 617.

perhaps more cost-effective alternatives to [a] proposed major regulation, consistent with the intent of SB 617."[4] Similarly, when rulemaking agencies (including CARB) objected to the burdens of preparing the early regulatory analyses of costs and benefits needed for an effective SB 617 process, the Department correctly concluded that the amended APA "clearly contemplates that an agency will have considered [regulatory] alternatives prior to filing a notice of a proposed action" with the Office of Administrative Law and publication of the regulatory notice for further public comment.[5] The Department also made it clear that under the SB 617 process, the "no action" alternative to regulation -- which is an outcome seldom if ever seen in a major California rulemaking -- had to receive full and fair consideration at the beginning of the rulemaking process.[6]

In requiring significant change in the California rulemaking process, the statute and the implementing regulations are salutary. The LCFS regulation in 2009 was typical of major rulemakings affecting the motor vehicle fuels industries in California. Beginning in 2008, CARB had convened a series of public consultation meetings prior to its formal proposal for rulemaking in March 2009. Not until publication of the Initial Statement of Reasons for the LCFS regulation, however, was the public given any opportunity to review the economic analysis of costs and benefits for the proposed regulation; the written comments on economic issues were due a scant 45 days later (in April 2009), and at the Board's April 2009 public hearing, most private-sector speakers were limited to five minutes to make a presentation to

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4 *See* Chart A at 24.

5 *Id.* at 27.

6 *Id.* at 47-48.

CARB. The public cannot have a significant role in serious economic analysis of a major regulation within such a constrained process.

Unsurprisingly, major economic assumptions and issues were not fully addressed within the time frame for written comments in March to April 2009, nor at the Board hearing. Among the assumptions and factors that could not as a practical matter be "pressure-tested" in the public comment process was the CARB staff's belief that advanced ethanol production methods would eventually drive down gasoline costs at the retail level and make the LCFS program cost-neutral for California consumers or even generate savings of up to $11 billion.[7] That assumption was unsound in 2009, and has since been disproven by experience.[8] Likewise, in the 2009 rulemaking, the CARB staff gave little attention to the ability of the federal RFS program to accomplish the same goals and purposes of the LCFS regulation, and offered largely opaque comparisons between the GHG reductions that the two programs could achieve. Now in its fifth year of implementation, the LCFS regulation has made little or no impact on the supply of lower-GHG fuels in California.[9] SB 617 and the Department's implementing regulations require the Board to improve the quality and depth of the economic analysis for major regulations like the LCFS program.

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[7] Air Resources Board, *Proposed Regulation to Implement the Low Carbon Fuel Standard -- Staff Report: Initial Statement of Reasons* (hereinafter "ISOR") at ES-26.

[8] As the ISOR itself noted, "Economic factors, such as tight supplies of lower-carbon-intensity fuels ... could result in overall net costs, not savings, for the LCFS." The fact that the cost savings forecast in 2009 proved ephemeral is implicit in the CARB staff's decision, less than two years after the regulation went into effect, to develop "cost reduction" features for the LCFS regulation, which would assist "regulated parties ... unable to meet their compliance obligations ... due to limited supplies of low carbon fuels or LCFS credits in the market." Air Resources Board, *Low Carbon Fuel Standard 2011 Program Review Report* (Dec. 8, 2011) (hereinafter "2011 Program Review") 16.

[9] There have been substantial increases in the efficiency of Midwest corn ethanol production facilities since CARB first embarked on the LCFS rulemaking, and those increases have reduced the lifecycle GHG emissions of those facilities under some analyses; but those reductions in GHG emissions have been caused by market forces (the need to reduce energy consumption in order to remain competitive), not by virtue of the LCFS regulation. *See* note 25 below.

II. Factors Affecting the Regulatory Alternatives Analysis

According to the CARB staff, the goal of the LCFS regulation in 2009 was, and still remains, to "reduce the carbon intensity of transportation fuels used in California by at least 10 percent by 2020 from a 2010 baseline," and also to "support the development of a diversity of cleaner fuels with other attendant co-benefits."[10] Growth Energy sought clarification of the staff's description of the goals of the regulation for purposes of its input in the SB 617 process.[11] Lacking greater specificity or clarification, Growth Energy can only turn to the 2009 rulemaking, in which CARB quantified the "10 percent" target as being a reduction of 16 million metric tons of carbon dioxide equivalent ("MMTCO2eq") GHG emissions associated with combustion of transportation fuels in California, along with a 7 MMTCO2eq reduction in "upstream" emissions, yielding a total 23 MMTCO2eq reduction in worldwide annual GHG emissions in 2020.[12] As explained below, achieving the direct GHG emissions reduction attributed to the LCFS regulation in 2009 -- the 16 MMTCO2eq -- no longer requires the existence of the LCFS regulation.

LCFS 46-200

A. Changes in the Regulatory Baseline Since 2009

The most significant development in the regulatory baseline since 2009 has been the adoption and full implementation of the federal renewable fuels standard program under the Energy Independence and Security Act of 2007, pursuant to a Final Rule adopted by the U.S.

LCFS 46-201

[10] The staff identified that goal on June 5, 2014, well after the period for preparation of SB 617 public input had begun, in response to a specific request from Growth Energy. *See* Letter from D. Bearden to K. King, May 30, 2014 (included here as Attachment 1) *and* Letter from M. Waugh to D. Bearden, June 5, 2014 (included here as Attachment 2).

[11] *See* Letter from D. Bearden to M. Waugh, June 11, 2014 (included here as Attachment 3). To date, no response to Mr. Bearden's letter of June 11, 2014, has been received.

[12] *See* ISOR at VII-1. According to the 2009 ISOR, "These reductions account for a 10 percent reduction of the GHG emissions from the use of transportation fuel." *Id.* That 10 percent target, which the CARB staff also sometimes cites, originates in Executive Order S-01-07 of January 18, 2007. *See* Executive Order S-01-07, § 1, available at http://www.arb.ca.gov/fuels/lcfs/eos0107.pdf.

Environmental Protection Agency in 2010.[13] The federal RFS program assures an adequate supply of low-cost renewable fuel for California, *i.e.*, ethanol produced from corn starch at biorefineries located mainly in the Midwest.[14] Because ethanol produced by any method from any renewable feedstock has the same physical and chemical properties when used in motor fuel, gasoline blended with 10 percent ethanol will achieve the same reduction in exhaust or "tailpipe" GHG emissions regardless of the production process or renewable feedstock used to create the ethanol. Consequently, the portion of the 16 MMTCO2eq reduction in GHG emissions from the California transportation fleet operated on gasoline can and will be obtained by virtue of the federal RFS program.[15] Oil companies will continue to buy and blend ethanol into gasoline sold in California under the federal program even if there were no LCFS program, in order to comply with the federal RFS program. The portion of the California fleet operated on diesel fuel can also achieve its part of the 16 MMTCO2eq reduction in GHG emissions by virtue of the federal RFS

LCFS 46-201 cont.

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[13] *See* U.S. EPA, *Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Final Rule*, 75 Fed. Reg. 14,669 (Mar. 26, 2010) .

[14] The RFS program, which in its early stages was effectively non-binding on ethanol usage, has begun to cause substantial increases in biofuel production. Total production of biofuels has increased steadily over the last year and a half, reaching approximately 16 billion gallons in the 12 months through April 2014. *See* http://www.epa.gov/otaq/fuels/rfsdata/.

[15] The term "fleet," as used here, includes off-road vehicles and engines in other equipment.

When the CARB staff considered the matter in 2009, it made a number of assumptions about the efficacy of the federal RFS program that need to be reconsidered. The most significant assumption, which was empirically unsupported, was that the federal program (which at the time was still under development) would provide only 30 to 40 percent of the GHG reductions that the staff predicted for the LCFS program. That assumption appears to have been based on a belief that without the LCFS regulation, only 11.3 percent of the advanced or cellulosic biofuels required nationwide by the RFS program would be consumed in California, while a substantially higher amount of those fuels would be drawn from the nationwide fuel pool to California as the result of the LCFS regulation. The advanced biofuels required by the RFS regulation that would be drawn to California by the LCFS program would have been used elsewhere in the absence of the LCFS program, leading to the same reductions in GHG emissions. To the extent that the cellulosic ethanol industry has experienced limits on achieving full commercial launch, those are national and even global economic and technical factors that the existence of the LCFS regulation has not to date, and will not in the future, be able to change or influence.

program, because the federal program results in blending biodiesel and renewable diesel into diesel fuel produced from petroleum.[16]

LCFS 46-201 cont.

As for the portion of the California fleet powered in whole or in part with electricity or hydrogen, there is similarly no continuing need for the LCFS program, owing to other changes in the regulatory baseline since 2009. The Advanced Clean Cars program now assures that electricity and hydrogen will be full participants in the California transportation fuel pool. In 2009, CARB's baseline for the alternatives analysis of the LCFS regulation included the then-current version of the Board's regulations to control GHG emissions from new motor vehicles that had been adopted in 2004, and that set GHG emission standards for 2009 to 2016 model-year new vehicles, sometimes called the "Pavley standards." In addition, the baseline also included the then-current provisions of the agency's Zero Emission Vehicle ("ZEV") standards which require manufacturers offer electric and/or hydrogen fuel cell vehicles for sale in California. CARB has now adopted new-vehicle GHG standards applicable to 2017 to 2025 model-year new vehicles and has made significant revisions to the ZEV standards as part of the ACC rulemaking in 2012.[17]

LCFS 46-202

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[16] One reason why California is assured of receiving an adequate supply of ethanol is that ethanol for use in gasoline commands a higher price -- the so-called "California premium" -- in California than in other parts of the United States, as can be readily seen from data available under contract or license from the Oil Price Information Service ("OPIS"). While there are many reasons why the "California premium" exists, one major reason is that refineries producing finished gasoline products for the California retail market tend to have higher production costs than other refineries.

LCFS 46-201 cont.

[17] In its 2009 LCFS alternatives analysis, the CARB staff assumed that manufactures would sell more electric vehicles than required by the ZEV standards, as they existed in 2009. Vehicle manufacturer compliance with the ZEV, new vehicle GHG, and criteria emission standards is determined on a "fleet-average" basis. What this means is that to the extent that manufacturers sell more ZEVs than required, they can in turn sell greater numbers of less fuel efficient or higher emitting vehicles provided that they remain in compliance on average. In addition, manufacturers that over comply can sell "credits" to manufacturers that would not otherwise be in compliance. Therefore, even if the LCFS regulation might lead to greater demand and use of electric vehicles, there would be no net reduction in GHG emissions.

LCFS 46-202 cont.

CARB has also taken and is taking a number of actions to reduce GHG emissions associated with the use of diesel fuel in heavy-duty vehicles which also need to be taken into account in the baseline for the 2014 LCFS analysis. The relevant measures include California's Tractor-Trailer regulation adopted in 2008 which requires use of aerodynamic improvement devices and low-rolling resistance tires, as well as the Phase I and the soon-to-be proposed Phase II heavy-duty GHG regulations that impose specific GHG emission requirements on new heavy-duty vehicles beginning with the 2014 model-year.[18]

LCFS 46-203

B. Necessary Information for Development of a Detailed Alternative Program

In addition to properly defining the baseline for the alternatives analysis, it is important to have a clear and complete picture of the revised LCFS program that the CARB staff plans to propose. In addition to full information concerning the estimated benefits of the LCFS program (both in terms of GHG reductions and in any other relevant aspect), the currently unknown elements of that program include the following:

- Updated carbon intensity values for transportation fuels that will be included in the proposed 2014 LCFS regulation.
- The detailed form of any proposed "cost-containment" provisions which could allow parties subject to the LCFS regulation to comply with the program's standards, without actually achieving the CI reductions required under the regulation.
- CARB staff's current analysis of the manner in which regulated parties will most likely attempt to comply with the proposed 2014 LCFS.

LCFS 46-204

[18] In addition to ensuring that the GHG emissions reductions associated with those regulations are properly accounted for in the baseline for the 2014 LCFS, CARB staff must also ensure that they properly account for the fact that compliance with the latter regulations is determined on a manufacturer fleet average basis in order to avoid improper assignment of GHG reductions to the 2014 LCFS regulation.

- A full description of any other intended goals of the LCFS regulation, such as stimulating "fundamental" changes in the "transportation fuel pool," along with the metrics to be used to measure progress and success in meeting those other goals.[19]

LCFS 46-204 cont.

Contrary to the position taken in the CARB staff's recent correspondence with Growth Energy and in related postings on the CARB website, none of those elements have been disclosed to the public at present. In addition to providing that undisclosed information concerning its analysis, the CARB staff should address the following other pertinent questions, which follow from the foregoing review of changes in the regulatory baseline since 2009:

LCFS 46-205

- Does the CARB staff agree that the federal RFS program would, in the absence of an LCFS regulation, assure some level of reductions in GHG exhaust emissions from the California in-use vehicle population that is operated on gasoline? If not, why not; and if so, what would be that level of GHG emissions reductions, on an annual or some other specific basis, if the LCFS program were to be discontinued at the end of 2015?

LCFS 46-206

  - Does the staff have any disagreement with the position that the federal RFS program and the "California premium" (*see* note 15 above) would cause Midwest corn ethanol producers to continue preferentially to deliver ethanol to California, and cause the California gasoline marketing sector to blend that Midwest corn ethanol into gasoline up to the current 10 percent limit, even in the absence of the LCFS regulation? If so, what are the specific reasons why the staff disagrees?

LCFS 46-207

  - Does the staff believe that the LCFS regulation would result in wider usage of E85 in California than the federal RFS program would cause, and if so, what is the empirical basis for that view?

LCFS 46-208

  - Would a possible need for a diesel component to an LCFS program justify an unnecessary gasoline component for an LCFS program, and if so, why?

LCFS 46-209

- The 2009 regulatory analysis predicted that ultra-low-CI fuels would be available and would bring the costs of the LCFS program down to the point where the program would be cost-neutral at the consumer level, or would result in savings of up to $11 billion.[20]

LCFS 46-210

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[19] *See* Air Resources Board, *California's Low Carbon Fuel Standard -- Final Statement of Reasons* (hereinafter "FSOR") 24.

[20] *See* ISOR at ES-26.

Does that remain the CARB staff's position? If not, what will be the consumer costs of the staff's proposed revised LCFS regulation, predicted annually or in some other manner? What uncertainties and assumptions affect those cost estimates?

LCFS 46-210 cont.

- Are the ACC program and other vehicle-based GHG reduction programs adopted to implement AB 32 designed to obtain, and will they obtain, the maximum technologically feasible and cost effective reductions in GHG emissions from the new vehicles that are subject to those standards? (*See, e.g.*, Cal. Health & Safety Code § 38562(a).) If not, why not? With the ACC program and other non-LCFS regulations discussed above in Part II. A. now in place, would the LCFS program actually produce any incremental increase in the displacement of liquid motor vehicle fuels by electricity in ZEVs or hybrid electric vehicles or hydrogen in fuel cell vehicles? If so, what are the relevant increases, and on what assumptions do the predicted increases depend? Why would a vehicle manufacturer that over-achieved the ZEV requirement not use the credit gained from the overachievement by selling a higher-emitting conventional vehicle fleet? To what extent would the staff attribute to the LCFS program any displacement of vehicle miles traveled in conventional vehicles by vehicles powered by fuel cells, and what is the basis for that prediction?

LCFS 46-211

- The CARB staff sometimes refers to Executive Order S-07-01 as a basis for maintaining the LCFS regulation. Should the requirements of Executive Order S-07-01 be reconsidered in the current rulemaking process insofar as the Executive Order called for creation of the LCFS regulation? Does Executive Order S-07-01 limit in any way CARB's discretion in adopting and enforcing measures to implement AB 32? Does AB 32 require adoption and enforcement of the LCFS regulation, if the same GHG reductions that the LCFS regulation can achieve could be achieved by other means?

LCFS 46-212

- To the extent that the LCFS program is still intended to stimulate "fundamental changes in the transportation fuel pool" in California,[21] to what extent had the program succeeded in its first five years? Is achieving that objective consistent with the potential "cost reduction" mechanisms under consideration for a revised LCFS regulation? How should the Department and the public try to weigh that objective against the potential costs for California consumers and businesses in meeting that objective?

LCFS 46-213

Having now presented the above questions to the CARB staff, Growth Energy believes that the staff should address them in the SRIA for the Department, or concurrently in a separate submittal to the Department made available to the public, if the staff does not intend otherwise to respond to those questions. Each question bears on the need for the LCFS regulation, the costs and benefits of the LCFS regulation, or the legal authority that would limit the analysis of regulatory

LCFS 46-214

[21] *See* note 19 above.

alternatives. If the CARB staff does not believe that one or more of the above questions are relevant to the evaluation of regulatory alternatives, Growth Energy requests that the CARB staff explain why, with respect to each such question.

LCFS 46-214 cont.

III. Regulatory Alternatives

The CARB regulations adopted since 2009 and the federal RFS program adequately provide for full control of the direct GHG emissions from the California vehicle fleet that the LCFS regulation may have been intended to control. In 2009, CARB claimed that the LCFS regulation would provide additional GHG reductions on a lifecycle basis; the "upstream" component of the GHG benefits attributed to the LCFS regulation in 2009 was 7 MMTCO2eq in 2020.[22]

Putting to one side the question whether CARB has legal authority to adopt and enforce a regulation to control GHG emissions occurring outside California, there are several reasons to question whether the LCFS regulation actually achieves any reduction in upstream emissions. As CARB has recognized, the LCFS regulation has to date caused "fuel shuffling" -- ethanol that might have been sold in California prior to the LCFS regulation is still being produced, and is sold somewhere else.[23] Ethanol production processes and pathways that have putatively higher upstream emissions have, at this point, neither terminated nor curtailed operations as a result of the LCFS regulation.[24] In addition, many Midwest corn ethanol biorefineries have qualified for

LCFS 46-215

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[22] *See* ISOR at VII-1.

[23] *See* FSOR at 477 ("Without the wider adoption of fuel carbon-intensity standards, fuel producers are free to ship lower-carbon-intensity fuels to areas with such standards, while shipping higher-carbon-intensity fuels elsewhere. The end result of this fuel 'shuffling' process is little or no net change in fuel carbon-intensity on a global scale.") The "wider adoption" of LCFS-type standards to which CARB referred in the 2009 FSOR has not occurred.

[24] That is not to say, however, that the LCFS regulation is not injurious to the national market in ethanol, nor neutral in its impact on lifecycle GHG emissions. By causing fuel shuffling, the LCFS regulation disrupts the national market in ethanol, imposes costs, and increases transportation-related GHG emissions. Eventually, by effectively banning Midwest corn ethanol from California (if, for example, the LCFS for 2015 established in

lower-carbon-intensity LCFS "pathways" since 2009, on a scale that the CARB staff has admitted was "not expected in 2009."[25] Moreover, the estimates of upstream emissions attributed to Midwest corn ethanol in 2009 were grossly inflated: no one, including CARB, is still prepared to defend the indirect land-use change emissions factors accepted by CARB in 2009, and the current literature demonstrates that the "science" of indirect land-use change is too unreliable to be used as a basis for regulation.[26]

To the extent there is any remaining basis for attributing upstream GHG emissions reduction benefits to the LCFS regulation, those benefits certainly do not warrant the continuation or re-adoption of the LCFS regulation. The more efficient approach would be to adjust the cap-and-trade regulation in Title 17 of the *California Code of Regulations* to account for whatever increment of GHG emissions reductions would be forgone by eliminating the LCFS regulation.[27] To the extent necessary, modifications to the cap-and-trade regulation would be

LCFS 46-215 cont.

LCFS 46-216

LCFS 46-217

2009 were to be enforced), the LCFS regulation will leave California with no commercially viable method of complying with the standard; the staff appears to recognize this problem to some extent, with the currently ill-defined "cost reduction" features that it plans to propose. *See* Air Resources Board, *Low Carbon Fuel Standard Re-Adoption Concept Paper* (March 2014) at 6-7. The reduction in nationwide demand for Midwest corn ethanol will then also impose serious economic harm on the Midwest ethanol industry.

[25] *See* 2011 Program Review at 169. The Midwest ethanol production facilities that have qualified for lower-carbon-intensity LCFS pathways have not done so through modifications in their production processes intended to obtain those special LCFS pathways: they have a competitive incentive to increase efficiency, and would have done increased their efficiency in the absence of the LCFS regulation. A Growth Energy member has demonstrated this point in the ongoing *Rocky Mountain* litigation involving some aspects of the LCFS regulation. *See* Declaration of Erin Heupel, P.E. (included here as Attachment 6) ¶¶ 5-6. Notably, in the *Rocky Mountain* litigation, CARB offered no competent evidence to the contrary. As Ms. Heupel also demonstrated, the specific features of the LCFS regulation will eventually force even the highest-efficiency Midwest corn production facilities out of the California market. *See id.* ¶¶ 9-11.

LCFS 46-215 cont.

[26] The CARB staff has begun to revise and to reduce the indirect land-use change emission factors that were included in the 2009 LCFS regulation. *See* letter from G. Cooper to K. Sideco, April 9, 2014, available at http://www.arb.ca.gov/fuels/lcfs/regamend14/rfa_04092014.pdf. It remains Growth Energy's position that the modeling methods used by CARB to generate indirect land-use change values are too unreliable for use in a regulation intended to comply with AB 32. *See* Letter from D. Bearden to J. Goldstene, May 10, 2010 (included here as Attachment 4).

LCFS 46-216 cont.

[27] In 2009, CARB received substantial comments on the relative inefficiency of the LCFS approach from one of its independent peer reviewers, who urged that CARB consider a cap-and-trade alternative. *See*, e.g., FSOR at 24 (review by Dr. John Reilly); *see also id.* (summarizing Dr. Reilly's review as stating, "The economic analysis

LCFS 46-217 cont.

simple and straightforward. Initially, CARB should determine what, if any, upstream GHG reductions should be attributable to the LCFS regulation, using a scientifically reliable process. CARB would also need an appropriate estimate of the total GHG emissions expected from the use of gasoline and diesel fuel in 2020. A CARB emissions forecast prepared in 2010[28] indicates that total GHG emissions from gasoline and diesel fuel use in California are expected to be approximately 175 million metric tons in 2020 under business as usual conditions. Assuming that the generally required 22 percent reduction in emissions in 2020 under the cap-and-trade program[29] applies to gasoline and diesel fuel use, total 2020 emissions without the LCFS program would be about 135 million metric tons.

Continuing the analysis, and by way of example, suppose that the cap-and-trade regulation had to cover the entire annual 16 MMTCO2eq of GHG emissions that the CARB staff identified as the benefit of the LCFS regulation for 2020. That level of GHG control could be achieved by amending the cap-and-trade regulations to require providers of gasoline and diesel fuel to submit 151 (135+16) million metric tons of allowances – or in other words requiring gasoline and diesel fuel suppliers to surrender 1.11 (151/136) allowances for every ton of GHG emissions they report from the fuels they supply.[30]

LCFS 46-217 cont.

[for the LCFS regulation] was done incorrectly. It does not meet [the] technical standards of economics. The baseline assumptions are mutually inconsistent, and if these assumptions were executed in a proper model it would show that the LCS was unnecessary.") CARB stated in 2009 that it would consider the role of cap-and-trade further in addressing the objectives of the LCFS program once the cap-and-trade regulations were completed. *See* FSOR at 452.

[28] *See* Air Resources Board, "California GHG Emissions -- Forecast 2008-2020 (updated Oct. 28, 2010), available at http://www.arb.ca.gov/cc/inventory/data/tables/2020_ghg_emissions_forecast_2010-10-28.pdf

[29] This is based on the general percentage reduction requirements established by CARB for total allowances issued. *See* Air Resources Board, "Overview of ARB Emissions Trading Program (October 2011), available at http://www.arb.ca.gov/newsrel/2011/cap_trade_overview.pdf

[30] The cap-and-trade regulation already begins to take effect for the gasoline and diesel fuel marketing sector in 2015.

The modifications to the existing text of the cap-and-trade regulation would be minor and limited to section 95852(d) of the regulation.[31] Further, the CARB staff at its discretion could also create a compliance offset program in order to incentivize low- carbon intensity fuels similar to those in place which incentivize other innovative GHG reduction strategies.[32] Insofar as one goal of the APA is to eliminate unnecessary regulation, this approach would well-serve the goals

LCFS 46-218

[31] Thus, the text of section 95852(d), with the modification shown in italics, and assuming that the full 10 percent GHG emission reduction attributed to the LCFS regulation would be covered by cap-and-trade, would provide as follows:

> Suppliers of RBOB and Distillate Fuel Oils. A supplier of petroleum products covered under sections 95811(d) or 95812(d) has a compliance obligation *equal to 1.x allowances* for every metric ton CO_2e of GHG emissions included in an emissions data report that has received a positive or qualified positive emissions data verification statement or for which emissions have been assigned that would result from full combustion or oxidation of the quantities of the following fuels that are removed from the rack in California, sold to entities not licensed by the California Board of Equalization as a fuel supplier, or imported into California and not directly delivered to the bulk-transfer/terminal system as defined in section 95102 of MRR, except for products for which a final destination outside California can be demonstrated:
>
> (1) RBOB;
> (2) Distillate Fuel Oil No. 1; and
> (3) Distillate Fuel Oil No. 2.
>
> *The value of "x" above will be established by Executive Officer by the prior October 31 for each year beginning with 2015 to ensure that actual GHG emissions from the use of RBOB and Distillate Fuel Oil No. 1 and Distillate Fuel Oil No. 2 are reduced to the level that would have been achieved had the Carbon Intensity of those fuels been reduced according to the following schedule relative to 2010.*

Required Carbon Intensity Reduction Relative to 2010	
Year	Reduction
2015	2.7%
2016	3.7%
2017	5.2%
2018	6.7%
2019	8.2%
2020	10.0%

As illustrated above for 2020, the value of "x" would be 0.11 and the compliance obligation for suppliers of gasoline and diesel fuels would be 1.11 times the number of tons of CO_2e emissions reported.

[32] *See* Air Resources Board, "Climate Change Programs -- Compliance Offset Program" (updated June 11, 2014), available at http://www.arb.ca.gov/cc/capandtrade/offsets/offsets.htm

of the APA. By eliminating the LCFS regulation, CARB would also free the California transportation fuel sector from continuing uncertainty about the availability and cost of ultra-low-carbon-intensity alternative fuels necessary for future compliance with the LCFS. As the Western States Petroleum Association ("WSPA") has stated:

> The LCFS, as envisioned by Governor Schwarzenegger in his Executive Order and as developed by the ARB, is infeasible. ... [S]taying the course now could result in disruptions in the transportation fuels markets. ... A successful fuels policy must protect against fuel supply disruptions, severe job losses in the state's refining industry and unacceptable economic harm to California and its citizens.[33]

LCFS 46-219

While Growth Energy believes that its proposal has sufficient merit without endorsement by other organizations, the concerns expressed by WSPA are important. One benefit of the change that Growth Energy is proposing, and a benefit that is particularly important to Growth Energy and the enterprises it represents, is that elimination of the LCFS regulation would eliminate a major conflict between regulations adopted by California and the federal RFS program, a conflict that will only increase if the LCFS regulation is re-adopted.

In considering Growth Energy's proposal, and in addition to the questions presented in Part II of this submittal, the CARB staff should in the SRIA address the following questions:

- The CARB staff's May 23, 2014, notice soliciting public input for the SRIA sought "alternative LCFS approaches." (See Attachment 5.) Does the CARB staff believe the alternatives analysis for the SRIA and public submittals related to the SRIA must be confined to regulatory alternatives that include or would preserve in some form the LCFS regulation? If so, what is the basis for such a limitation?

LCFS 46-220

- Other than emissions created in generating electricity for delivery in California, does AB 32 give CARB the authority to regulate upstream emissions occurring outside California, or to account for upstream emissions occurring outside

LCFS 46-221

[33] The reference is to Executive Order S-01-07, with its "10 percent" by 2020 goal, which according to the CARB staff remains the target for the LCFS regulation. *See* Letter from G. Grey to K. Sideco, June 13, 2014 at 2, available at http://www.arb.ca.gov/fuels/lcfs/regamend14/wspa_06132014.pdf. WSPA has also stated that modification of the LCFS program through "cost reduction" provisions would "simply penalize fuel suppliers for not meeting an infeasible standard." *See* Letter from C. Reheis-Boyd to K. Sideco, April 11, 2014 at 10, available at http://www.arb.ca.gov/fuels/lcfs/regamend14/wspa_04112014.pdf.

LCFS 46-219 cont.

California in adopting regulations to meet the statewide greenhouse gas emissions limit? (*See* Cal. Health & Safety Code § 38505(m), (n); 38562(a).) If AB 32 authorizes CARB to regulate or consider out-of-state GHG emissions attributed to ethanol production, does AB 32 also authorize CARB to address those emissions through the cap-and-trade regulation?

LCFS 46-221 cont.

- Can the California cap-and-trade regulations be modified to provide the same numerical reductions in GHG emissions as the LCFS regulation? If not, why not?

LCFS 46-222

- If the CARB staff is concerned that the state measures to control GHG emissions and the federal RFS program might not be fully implemented and enforced at some time in the future, would adoption of a revised LCFS regulation as a "backstop" measure, to be implemented only if those other programs are not meeting defined objectives, address that concern? If not, why not?

LCFS 46-223

- If the CARB staff believes some regulated parties might prefer to comply with a revised LCFS regulation rather than a modified cap-and-trade regulation, could that issue be addressed by including a revised LCFS as a part of a regulatory alternative (with appropriate opt-in provisions) that would be an option for parties that did not wish to comply with a modified cap-and-trade regulation?

LCFS 46-224

- What are the current and expected future levels of resources at CARB, in terms of personnel and other resources, that are allocated to the LCFS regulation? What would be the budgetary impact for CARB if the LCFS program were eliminated? What would be the budgetary impact for CARB caused by the change in the cap-and-trade regulation proposed here?

LCFS 46-225

- To the extent the CARB staff would attribute other beneficial impacts, different from GHG emissions reductions, to the LCFS regulation, to whom do those benefits accrue? With regard to those other beneficial impacts, are California consumers benefitted and, if so, how and to what extent? With regard to those other beneficial impacts, are California businesses benefitted and if so, how and to what extent? Do those other beneficial impacts justify or support continuation of the LCFS regulation, and if so, what is the basis for CARB's authority to adopt and enforce the LCFS regulation to obtain those benefits? If those other beneficial impacts include the possibility that sources for alternative fuels will be increased or diversified, are there any peer-reviewed or other studies that support such a proposition? If not, what is the staff's basis for attributing such benefits to the LCFS regulation? Could those benefits be realized through the development of a compliance offset program under the cap-and-trade regulation?

LCFS 46-226

As with the questions presented in Part II, the CARB staff's responses to these questions are important in understanding its evaluation of Growth Energy's proposal. If the CARB staff does not believe that one or more of the above questions are relevant to the evaluation of

LCFS 46-227

regulatory alternatives, Growth Energy requests that the CARB staff explain why, with respect to each such question.

LCFS 46-227 cont.

IV. Next Steps

As noted at the outset of this submittal, Growth Energy's analysis of alternatives to the LCFS regulation can be no more detailed than the available information about the staff's intended revised LCFS regulation. If CARB does nothing further to facilitate the public input into the SB 617 process for use in the SRIA, it will not have substantially complied with the APA as amended by SB 617 and implemented in the Department's regulations.

LCFS 46-228

In the CARB staff's first notice that it was ready to receive public input on regulatory alternatives, published on May 23, 2014, the staff set a deadline for that input of June 6, 2014 -- nine business days later. The staff indicated in that notice that the public should, among other things, "submit the quantities of low-CI fuels used each year" in the proposed alternative to the LCFS regulation, "as well as the associated cost and benefit information, and their sources." [34] According to the May 23 notice, that information was needed "to enable comparison of economic impacts."[35] The May 23 notice stated that the objective for public input should be to provide "alternative LCFS approaches," meaning "any approach that may yield the same or greater benefits than those associated with the proposed regulation, or that may achieve the goals at lower cost."[36]

LCFS 46-229

The "proposed regulation" to which the May 23 proposal referred (i) had not been provided to the public for review as of May 23, nor (ii) has it been provided at any time since

[34] *See* Attachment 5.

[35] *Id.*

[36] *Id.*

May 23.[37] The May 23 notice was not accompanied by any information that provided the CARB staff's own prediction of "the quantities of low-CI fuels [that would be] used each year" under the CARB staff's proposed regulation, nor the benefits that the CARB staff attributed to the LCFS regulation. Growth Energy requested that the CARB staff give the public the information needed to prepare a complete SB 617 submission and requested that the public be given additional time to prepare SB 617 analyses after the necessary information was released.[38]

The CARB staff responded by extending the deadline for public submittals that would be addressed in the SRIA to June 23, 2014 (31 days after the May 23 notice), but did not provide any of the information requested by Growth Energy and needed to provide the type of input sought in the May 23 notice, and necessary under the Department's SB 617 regulations. Instead, the staff referred to the GHG emissions reductions targeted in the 2009 rulemaking, to a March 2014 "Concept Paper" that discussed the staff's approach to revision of the LCFS regulation, and to material provided to the public in connection with regulatory workshops held in ARB's offices.[39] The March 2014 Concept Paper raises more questions about the staff's approach than it answers: it included, for example, a general description of two different "cost reduction" concepts without indicating how either of them would work, how they would reduce costs, or how they would affect the GHG emissions reduction benefits of the LCFS program. If the March 2014 Concept Paper provided a basis for preparing SB 617 submittals, then there is no reason why the CARB staff should have waited until May 23 to solicit public input under the Department's regulations. Had the staff informed the public when it released the Concept Paper

LCFS 46-229 cont.

[37] The CARB staff has released some draft regulatory text for their proposed revised LCFS, but that partial text does not include, for example, the "cost reduction" feature intended for the new regulation, nor the carbon intensity values to be assigned to each alternative fuel.

[38] *See* Attachment 1.

[39] *See* Attachment 2.

and discussed the Concept Paper at one of its March 2014 regulatory workshops that the Concept Paper was intended to provide a basis for SB 617 input, Growth Energy (and perhaps other stakeholders) would have pointed out at that time that the Concept Paper was inadequate for that purpose; in that event, perhaps the CARB staff would have been able to provide the necessary information for public input into the SRIA.

LCFS 46-229 cont.

The materials provided in connection with the regulatory workshops -- including the partial regulatory text released on May 28, after the staff had launched the public input process -- likewise do not provide the necessary information for detailed public submittals consistent with SB 617 and the Department's regulations. Growth Energy has studied those materials carefully, and with the greatest respect, would challenge the CARB staff to indicate where in those materials the staff identifies GHG emissions reduction targets for a revised LCFS regulation; where the staff identifies any other putative benefits of the LCFS regulation; and where in those materials the staff provides specific and concrete information about the impact of the "cost reduction" concepts on the quantities of alternative fuels that would be used in order to comply with the revised LCFS regulation, or permits a quantification of costs and benefits of a revised LCFS regulation that includes a cost-reduction feature.

LCFS 46-230

Finally, it is important to address comments by the CARB staff at one recent workshop, which suggested that the timing of the current regulatory effort has been affected by the Board's need to comply with the mandate in litigation under the APA and the California Environmental Quality Act ("CEQA").[40] In that litigation, the Superior Court has allowed CARB all the time

LCFS 46-231

[40] The case is *POET LLC et al. v. California Air Resources Board*, Case No. 09 CE CG 04659 (Sup'r Ct., Fresno County). The Writ of Mandate in that proceeding does not require CARB to commence or conclude rulemaking by a particular date, but to proceed in good faith without delay. The Writ of Mandate was issued more than six months ago, by which time CARB presumably knew that it had to comply with the Department's SB 617 regulations.

that the Board has requested in order to comply with the mandate. If CARB needs more time in order to conduct the SB 617 process in a manner that allows sufficient time for effective public input into the preparation of an SRIA, CARB should so inform the Superior Court. (Notably, in its filings with the Superior Court, CARB has not adverted to SB 617 or the Department's implementing regulations.) In addition, the CARB staff would surely agree that even before issuance of the mandate in that litigation, it was aware that it had major program review obligations for the LCFS regulation in 2014.[41] Particularly in light of those program review obligations, the CARB staff's inability to provide more information now to the public, needed to participate fully in the SB 617 process, seems inexcusable.

LCFS 46-231 cont.

Against that backdrop, Growth Energy urges the CARB staff to reconsider its present approach to the SB 617 process, and specifically the staff's approach to obtaining public input for the SRIA. As the staff might expect, if one response to Growth Energy's proposed regulatory

LCFS 46-232

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[41] In 2009, when it first adopted the LCFS regulation, the Board directed the CARB staff to conduct and to present by January 1, 2015 a "review of implementation of the LCFS program" that was to "include, at a minimum, consideration of the following areas:

> "(1) The LCFS program's progress against LCFS targets;
> "(2) Adjustments to the compliance schedule, if needed;
> "(3) Advances in full, fuel-lifecycle assessments;
> "(4) Advances in fuels and production technologies, including the feasibility and cost-effectiveness of such advances;
> "(5) The availability and use of ultralow carbon fuels to achieve the LCFS standards and advisability of establishing additional mechanisms to incentivize higher volumes of these fuels to be used;
> "(6) An assessment of supply availabilities and the rates of commercialization of fuels and vehicles;
> "(7) The LCFS program's impact on the State's fuel supplies;
> "(8) The LCFS program's impact on state revenues, consumers, and economic growth;
> ...
> "(12) Significant economic issues; fuel adequacy, reliability, and supply issues; and environmental issues that have arisen; and
> "(13) The advisability of harmonizing with international, federal, regional, and state LCFS and lifecycle assessments."

17 C.C.R. § 95489(a).

LCFS 46-231 cont.

alternative is that Growth Energy's proposal lacks a detailed comparison with the costs, benefits, and cost-effectiveness of the staff's proposal in the SRIA, Growth Energy will attribute its lack of specificity to the staff's failure to provide the information needed to offer a more specific regulatory analysis. Because this is one of the first major rulemakings at CARB that is required to comply with SB 617 and the Department's SB 617 regulations, it is also important for the Department to take a proactive role in providing guidance to CARB, the stakeholders, and other members of the public interested in the LCFS program.

LCFS 46-232 cont.

Respectfully submitted,

GROWTH ENERGY

17_OP_ADF_GE Responses (Page 191 – 218)

110. Comment: **LCFS 46-195 through LCFS 46-232**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Regulation Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

Appendix G

GHG Emissions Impact of Fuel Shuffling Due to California Low Carbon Fuel Standard

AIR, Inc.

February 14, 2015

The California LCFS requires a 10% reduction in carbon intensity between 2010 and 2020 for fuels sold in California. Much of the GHG emission reductions come from biofuels that are mixed with either gasoline or diesel fuel. Biofuel production has increased in the US and elsewhere. There are two possible scenarios for where the biofuels are used. In one scenario, where the LCFS is not in effect, the carbon intensity of biofuels used is approximately the same inside and outside of California. Biofuels are generally used where they are produced, and transportation emissions for biofuels are minimized. For example, ethanol from corn is used in the US, and ethanol from Brazil is used in Brazil. In a second scenario where the LCFS is in effect, the LCFS causes lower carbon intensity biofuels to flow into California for use there. All other biofuel production, which may have slightly higher average carbon intensity than the average in California, is used outside of California. In this second case, global GHG emissions can actually increase, because the same quantity of biofuel is used in either case, but in the second case, transport GHG emissions are higher, because biofuels are not being used where they were produced. This overall concept is referred to as fuel shuffling.

The LCFS requirement causes fuel shuffling, because the regulation is expected to result in increasing amounts of cane ethanol from Brazil to be used in California. This is shown in Table B-18 below, which shows volumes of different types of ethanol that ARB expects under one of the possible compliance scenarios (see Table B-18 of Appendix B to the ISOR). In California corn and related ethanol (sorghum) declines, while other fuels, notably cane ethanol, increases. However, while corn ethanol declines in California, it does not decline elsewhere, but increases with the RFS and with exports. Thus, worldwide there is no change in GHG emissions worldwide just because corn ethanol declines in California. However, the shift from corn ethanol to cane ethanol causes an increase in ethanol transportation and distribution emissions because of the difference in transportation distances between the Midwest to California and Brazil to California.

LCFS 46-233

Table B-18. Illustrative California Reformulated Gasoline Oxygenates and Substitute Fuels through 2020							
Fuel	2014	2015	2016	2017	2018	2019	2020
Corn and related ethanol, mmg	1,400	1,350	1,250	1,175	1,000	925	875
Cane and sugar ethanol, mmg	120	170	240	290	410	460	510
Cellulosic ethanol, mmg	0	0	5	15	50	75	100
Renewable gasoline, mmg	0	0	0	0	5	15	25
Hydrogen, mmgGGE	0.03	0.4	1	2	4	5	7
Electricity for LDVs, mmgGGE	9	14	19	24	31	40	51

We first estimated the GHG emission impact of increased transportation emissions with CaGREET2.0. We used distances and modes of transportation provided in CAGREET2.0. Results are shown in Table 1 below. For this analysis we assume a 390 million gallon per year increase in cane ethanol and a corresponding decrease in corn ethanol, which is the difference in the 2020 cane ethanol value (510 million gallons per year) and the 2014 value (120 million gallons per year) in Table B-18 above. Results show a 145,000 ton per year increase in GHG emissions, which is the fuel shuffling effect, assuming GREET cane ethanol transport emissions are correct.

LCFS 46-233 cont.

Table 1. Extra Transport GHG Emissions from Brazil Sugar Cane Ethanol								
	Emission Factors (grams/MMBTU of Fuel Transported)			Emissions		Emissions, CO2e		
Pollutant	Brazil to LA/Long Beach *	Midwest to CA **	Difference	Billion Grams	GWP	Billion Grams	Short Tons	gCO2e/ MJ
VOC	5.109	1.321	3.788	0.113	3.12	0.351	387	0.0112
CO	12.221	4.428	7.793	0.232	1.57	0.365	402	0.0116
CH4	7.896	3.051	4.845	0.144	25.	3.605	3,974	0.1148
N2O	0.141	0.051	0.090	0.003	298.	0.801	882	0.0255
CO2	6,577.633	2,326.555	4,251.078	126.549	1.	126.549	139,496	4.0292
					Totals:	131.671	145,142	4.1923

*Brazil to LA/Long Beach includes: Pipeline, Rail, Truck, Ocean Tanker, and USTruck.
**Midwest to CA includes: Rail, Truck, and Truck.

A report by (S&T)^2, however, shows that the CaGREET2.0 transport emissions for cane ethanol could be quite low. [1] We used the same transport distances from Table 1 and information from the (S&T)^2 report to estimate emissions, both with and without a backhaul included. Results are in Table 2 (details shown in Attachment 1) and show that the fuel shuffling emissions are between 375,000 and 716,000 tons of GHG per year.

Table 2. Increase in Fuel Shuffling GHG Emissions	
Case	Extra Fuel Shuffling Emissions (GHG, tpy)
Ca GREET2.0	132,000
(S&T)^2, no backhaul	375,000
(S&T)^2, with backhaul	716,000

LCFS 46-233 cont.

[1] *REVIEW OF THE SUGAR CANE ETHANOL PATHWAYS IN CA-GREET 2.0,* (S&T)^2 for Growth Energy, February 2, 2015.

Attachment 1

Details of Fuel Shuffling Estimates for (S&T)^2 Transport Emissions

Without Backhaul

Pollutant	Emission Factors (grams/MMBTU of Fuel Transported) Brazil to LA/Long Beach *	Midwest to CA **	Difference	Emissions Billion Grams	GWP	Emissions, CO2e Billion Grams	Short Tons	gCO2e/ MJ
VOC	11.288	1.321	9.967	0.297	3.12	0.925	1,019	0.0294
CO	26.352	4.428	21.924	0.653	1.57	1.026	1,131	0.0327
CH4	15.595	3.051	12.544	0.373	25.	9.336	10,291	0.2972
N2O	0.297	0.051	0.246	0.007	298.	2.181	2,405	0.0695
CO2	13,289.690	2,326.555	10,963.134	326.358	1.	326.358	359,748	10.3910
					Totals:	339.826	374,594	10.8198

*Brazil to LA/Long Beach includes: Pipeline, Rail, Truck, Ocean Tanker, and USTruck.
**Midwest to CA includes: Rail and two Trucks.

With Backhaul

Pollutant	Emission Factors (grams/MMBTU of Fuel Transported) Brazil to LA/Long Beach *	Midwest to CA **	Difference	Emissions Billion Grams	GWP	Emissions, CO2e Billion Grams	Short Tons	gCO2e/ MJ
VOC	20.483	1.321	19.162	0.570	3.12	1.778	1,960	0.0566
CO	47.382	4.428	42.953	1.279	1.57	2.009	2,215	0.0640
CH4	27.054	3.051	24.003	0.715	25.	17.863	19,691	0.5688
N2O	0.529	0.051	0.478	0.014	298.	4.236	4,670	0.1349
CO2	23,278.251	2,326.555	20,951.696	623.705	1.	623.705	687,517	19.8584
					Totals:	649.592	716,052	20.6826

*Brazil to LA/Long Beach includes: Pipeline, Rail, Truck, Ocean Tanker, and USTruck.
**Midwest to CA includes: Rail and two Trucks.

LCFS 46-233 cont.

17_OP_ADF_GE Responses (Page 219 – 223)

111. Comment: **LCFS 46-233**

Agency Response:
The response to this comment is in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

Appendix H

Appendix H

Impact of the LCFS on Global Climate

A quantitative modeling analysis was conducted to assess the impact of LCFS carbon emission reductions on global climate change.

Climate Model Summary – The effect of the LCFS ISOR estimates of CO_2 emissions reductions attributable to the proposed regulation were modeled using version 5.3 of a coupled, gas-cycle/climate model known as MAGICC (Model to Assess Greenhouse-gas Induced Climate Change). MAGICC has been the primary model used by the Intergovernmental Panel on Climate Change (IPCC) to produce projections of future global-mean temperature and sea level rise. Technical and user manuals explaining the model in more detail are publicly available.[1]

Version 5.3 is the latest version of MAGICC and was updated from version 4.1 to be consistent with the IPCC Fourth Assessment Report, Working Group 1 (AR4).[2] (Version 4.1 uses the earlier IPCC Third Assessment Report, Working Group 1 (TAR) climate couplings.) Updates reflected in MAGICC version 5.3 include:

LCFS 46-234

- Climate sensitivity estimates updated based on AR4;
- Revised climate forcing values consistent with AR4;
- Updated carbon cycle modeling and CO_2 concentration stabilization scenarios;
- More realistic sea level rise projection method; and
- Minor "balancing" revision to methane and nitrous oxide budgets.

For purposes of this analysis, the updated climate sensitivity estimate from AR4 is the most noteworthy. The default climate sensitivity for a doubling of CO_2 has been upwardly revised from 2.6°C to 3.0°C in MAGICC version 5.3.

The key parameters for the MAGICC v5.3 modeling were as follows:

a) "mid"-level response for the carbon cycle model,
b) carbon cycle climate feedbacks set to "on,"
c) "mid"-level response for aerosol forcing,
d) 3.0° C sensitivity for doubled CO_2,
e) "variable" thermohaline circulation,
f) vertical oceanic diffusion coefficient set to "2.3 cm^2/s," and
g) "mid"-level ice melt sensitivity.

[1] T.M.L. Wigley, "MAGICC/SCENGEN 5.3: User Manual," National Center for Atmospheric Research, Colorado, September 2008.
[2] The IPCC released its Fifth Assessment Report (AR5), in October 2014. The MAGICC model has not yet been updated to reflect AR5.

Again the 3.0° C sensitivity to doubled CO_2 is consistent with the assumptions used in the IPCC AR4 report, which is based on the assumption that the surface temperature record accurately reflects the effect of greenhouse gas concentrations on ambient temperatures. Explanations of the other parameters are available in the above-referenced user manual.

Emission Inputs – The baseline case assumed a future in which fossil fuels will continue to be consumed in a "business as usual" manner, but with new sources of energy mixing in to supply a balance of non-carbon emitting sources. This baseline emissions case (named A1B-AIM) produces total climate forcing in 2005 that most closely approximates that in IPCC AR4 (A1B=1.596 W/m^2, AR4=1.6 W/m^2). Two different alternative scenarios were run to evaluate the potential effect of the proposed LCFS as summarized below:

1. *LCFS-CA:* This scenario applied the CARB LCFS ISOR estimated reduction in CO_2 emissions from 2020 (20.7 MMT[3] CO_2e). These reductions were held constant on a relative basis from 2020 through 2050.

2. *LCFS-US:* This second scenario assumed the reductions estimated in the LCFS ISOR would be increased by a factor of 8.9 to scale the California reductions to the entire U.S. based on California vs. entire U.S. transportation source CO_2 emission estimates published by the U.S. Energy Information Administration (EIA).

LCFS 46-234 cont.

Table 1 summarizes the baseline global fossil fuel CO_2 emissions by calendar year from the AR4-A1B-AIM reference case contained in the MAGICC v5.3 emissions scenario library. The emission units for fossil CO_2 are petagrams (10^{15} grams) as noted at the bottom of Table 1. As shown in Table 1, baseline emissions under the AR4 A1B-AIM reference case are projected to rise steadily from 1990 through 2050, with 2050 emissions roughly 2.7 times higher than those in 1990.

Table 1
Baseline Scenario
Global Fossil Fuel CO_2 Emissions (Pg C[a])

Calendar Year	Annual Emissions
1990	5.991
2000	6.896
2010	9.680
2020	12.122
2030	14.011
2040	14.945
2050	16.009

[a] Petagrams of carbon; 1 petagram = 10^{15} grams

[3] MMT = million metric tons (1 metric ton = 1,000 kilograms or 1,000,000 grams)

Emissions under the LCFS-CA and LCFS-US scenarios were calculated from these baseline estimates as follows. First, the CARB ISOR LCFS emission reductions in 2020 (20.7 MMT CO_2e) were converted to "petagram carbon" units for input into MAGICC as follows:

$$20.7\ MMTCO2e \times \frac{12.01\ g/mole\ C}{44.01\ g/mole\ CO2} \times \frac{1\ Pg}{10^3\ MMT} = 5.65 \times 10^{-3}\ Pg\ C$$

This reduction in 2020 emissions estimated in the CARB ISOR represents a 0.0047% decrease (5.65×10^{-3}/12.112 Pg C) in global fossil CO_2 emissions relative to the 2020 baseline. Since the ISOR reductions are expressed on a CO_2 equivalent basis, they were applied to the fossil fuel carbon emission estimates in MAGICC (although the model also includes emission estimates for other GHG compounds.)

In applying this LCFS reduction beyond 2020, out to 2050, two approaches were considered: 1) using the same absolute reduction (5.65×10^{-3} Pg C) for each future year; and 2) applying the same relative 2020 reduction (0.0466%) in each future year. The relative reduction approach produced nominally greater reductions (i.e., lower emissions) in future years. Thus, the relative reduction-based emissions were used in the climate modeling.

LCFS 46-234 cont.

These California LCFS emission reductions were extrapolated to the second scenario representing nationwide LCFS adoption based on a scaling multiplier developed from EIA estimates of calendar year 2011 transportation sector CO_2 emissions by individual state.[4] EIA estimated 2011 transportation sector emissions of 199.3 and 1,781.9 $MMTCO_2$ in California and the entire U.S., respectively. Thus a scaling factor of 8.94 was developed from this ratio (1781.9÷199.3). This scaling factor was then used to conflate the California LCFS reductions from the ISOR to the entire U.S. For example in 2020, U.S. LCFS reductions were calculated as follows:

> *LCFS-CA Relative Reduction × Scaling Factor × 2020 Global Emissions, or*
> 0.0466% × 8.94 × 12.122 Pg C = 0.051 Pg C reduction in 2020 CO_2 emissions

Table 2 presents a comparison of the resulting global emission estimates input to the MAGICC model for the baseline case and each of the two LCFS reduction analysis scenarios. Note that these values are emissions, not LCFS reductions (which are represented by the difference between the baseline and scenario emissions in the table).

[4] U.S. Energy Information Administration (EIA), 2011 State energy-related carbon dioxide emissions by sector, http://www.eia.gov/environment/emissions/state/analysis/.

Table 2 Comparison of Baseline and LCFS Reduction Scenario Annual Emissions (Pg C) Used in MAGICC Modeling			
Calendar Year	Baseline (A1B-AIM)	LCFS in California	LCFS in Entire U.S.
1990	5.991	5.991	5.991
2000	6.896	6.896	6.896
2010	9.680	9.680	9.680
2020	12.122	12.116	12.071
2030	14.011	14.004	13.953
2040	14.945	14.938	14.883
2050	16.009	16.002	15.942

The highlighted cells in Table 2 denote those years and emissions that reflect LCFS reductions relative to baseline estimates.

LCFS 46-234 cont.

Climate Modeling Results – Table 3 shows modeled changes in ambient temperature from a 1990 baseline temperature for each case. As shown in the table, the baseline case produces an estimated increase of 0.9952°C in calendar year 2050 over the 1990 baseline. The addition of the LCFS standard is estimated to reduce this temperature increase by two ten-thousandths of a degree (0.0002). Assuming roughly nine times greater reductions to reflect LCFS implementation throughout the U.S., the temperature increase is reduced by 2.0 thousandths of a degree (0.0020).

Table 3 MAGICC Version 5.3 Model Results (°C) for Calendar Year 2050		
Scenario	Temperature Change from 1990 Baseline	Change Due to LCFS
Baseline (IPCC Case A1B)	0.9552	n.a.
Low Carbon Fuel Standard in California	0.9550	0.0002
Low Carbon Fuel Standard throughout U.S.	0.9532	0.0020

Appendix I

17_OP_ADF_GE Responses (Page 224 – 229)

112. Comment: **LCFS 46-234**

Agency Response:
The response to this comment is in the Low Carbon Fuel Standard Regulation Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

STATE OF CALIFORNIA

BEFORE THE AIR RESOURCES BOARD

Declaration of James M. Lyons

I, James Michael Lyons, declare as follows:

1. I make this Declaration based upon my own personal knowledge and my familiarity with the matters recited herein. It is based on my experience of nearly 30 years as a regulator, consultant, and professional in the field of emissions and air pollution control. A copy of my résumé can be found in Attachment A.

2. I am a Senior Partner of Sierra Research, Inc., an environmental consulting firm located at 1801 J Street, Sacramento, California owned by Trinity Consultants, Inc. Sierra specializes in research and regulatory matters pertaining to air pollution control, and does work for both governmental and private industry clients. I have been employed at Sierra Research since 1991. I received a B.S. degree in Chemistry from the University of California, Irvine, and a M.S. Degree in Chemical Engineering from the University of California, Los Angeles. Before joining Sierra in 1991, I was employed by the State of California at the Mobile Source Division of the California Air Resources Board (CARB).

3. During my career, I have worked on many projects related to the following areas: 1) the assessment of emissions from on- and non-road mobile sources, 2) assessment of the impacts of changes in fuel composition and alternative fuels on engine emissions including emissions of green-house gases, 3) analyses of the unintended consequences of regulatory actions, and 4) the feasibility of compliance with air quality regulations.

4. I have testified as an expert under state and federal court rules in cases involving CARB regulations for gasoline, Stage II vapor recovery systems and their design, factors affecting emissions from diesel vehicles, evaporative emission control system design and function, as well as combustion chamber system design. While at Sierra I have acted as a consultant on automobile air pollution control matters for CARB and for the United States Environmental Protection Agency. I am a member of the American Chemical Society and the Society of Automotive Engineers and have co-authored nine peer-reviewed monographs concerned with automotive emissions including greenhouse gases and their control. In addition, over the course of my career, I have conducted peer-reviews of numerous papers related to a wide variety of issues associated with pollutant emissions and air quality.

5. This Declaration summarizes the results of analyses I have performed regarding CARB staff's analysis of different aspects of the re-adoption of the Low Carbon Fuel Standard (LCFS) Regulation and Regulation on the Commercialization of Alternative Diesel Fuels (ADFs) as an independent expert for Growth Energy. If called upon to do so, I would testify in accord with the facts and opinions presented here.

6. Based on a review of the Initial Statement of Reasons (ISOR) for the LCFS regulation and the associated appendices, including the draft Environmental Analysis, it is clear that CARB staff failed to quantify the GHG emission reductions associated with the LCFS regulation itself. Rather, staff notes that the GHG reduction estimates provide are inflated as the result of the "double counting" of GHG reductions due to other regulatory programs. LCFS 46-235

7. Further, this review shows that CARB staff failed to perform a complete analysis of the potential air quality impacts associated with the LCFS regulation. More specifically, CARB staff's air quality analysis fails to quantitatively assess the impact of the LCFS and ADF on all emission sources that could be affected nor does it consider all of the pollutants for which emission changes might occur. A summary of the review is Attachment B to this declaration. LCFS 46-236

8. CARB staff rejected a proposed alternative to the LCFS regulation submitted by Growth Energy claiming that it will likely result in the same environmental benefits, but not ensure a transition to lower carbon intensity fuels that CARB staff claims is the main goal of the LCFS regulation. As discussed in detail in Attachment C to this declaration, CARB staff failed to perform any analysis of the Growth Energy Alternative and has provided no support for this finding. Because the Growth Energy Alternative provides greater environmental benefits and is expected to cost less than the LCFS regulation, it must be adopted by CARB instead of the LCFS regulation. LCFS 46-237

9. As part of the development of the ADF regulation, CARB staff examined the impacts of the proposed regulation on emissions of pollutants including oxides of nitrogen (NOx) emitted from heavy-duty diesel engines operating on blends of diesel fuel and biodiesel.

10. NOx emissions directly affect atmospheric levels of nitrogen dioxide, a compound for which a National Ambient Air Quality Standards (NAAQS) has been established. NOx emissions are also precursors to the formation of ozone and particulate matter, which are also pollutants for which NAAQS have been established. Areas of the South Coast and San Joaquin Valley air basins are in extreme and moderate non-attainment of the most recent ozone and fine particulate standards, respectively. LCFS 46-238

11. In the Initial Statement of Reasons (ISOR) for the ADF regulation and its' appendices, CARB staff summarized its analysis of increases in NOx emissions from heavy-duty diesel vehicles over the period from 2014 through 2023. The results of the staff's analysis are most clearly summarized in Table B-1 of Appendix B of the ISOR. This table shows that staff estimate that biodiesel use allowed under the ADF regulation will increase NOx emissions by 1.35 tons per day in 2014 and that the magnitude of this emission increase will drop to 0.01 ton per day by 2023. ADF 17-18

12. I have performed a review of the staff's assessment of the NOx emission impacts of biodiesel use allowed under the ADF regulation presented in ISOR and its' appendices and find it to be fundamentally flawed such that it is not reliable. First, the bases for total diesel NOx emissions inventory is not described in the ISOR or in other ADF 17-19

documents in the record. Second, CARB staff incorrectly assumes that the use of biodiesel in "New Technology Diesel Engines (NTDEs)" equipped with exhaust aftertreatment devices to lower NOx emissions will not lead to increased NOx emissions. Third, CARB staff incorrectly apply ratios of on-road vehicle travel by NTDEs from the now obsolete EMFAC2011 model to account for the amount of biodiesel used in all NTDEs including those found in non-road equipment. Fourth, to assess the overall impact of the ADF regulation on NOx emissions, CARB incorrectly subtracts NOx reductions resulting from the use of "renewable diesel fuel" from increases in NOx emissions resulting from the use of biodiesel.

ADF 17-19 cont.

13. In addition, I have performed a very conservative assessment of the NOx emission impacts of biodiesel use under the ADF that uses the latest CARB emissions models and corrects the flaws in the staff analysis, a summary of which is attached. The results of this assessment indicate that NOx increases from biodiesel will be much larger than those estimated by CARB staff and that the magnitude of the impacts will not decline over time as forecast by CARB staff. In addition, the analysis shows that the ADF regulation will lead to significant increases in NOx emissions in the South Coast and San Joaquin Valley air basins which are already in extreme non-attainment of the federal ozone NAAQS and moderate non-attainment of the federal fine particulate NAAQS. The details of both the review and revised emissions estimates are presented in Attachment D to this declaration.

ADF 17-20

14. In addition to identifying a fundamentally flawed analysis of the increases in NOx emissions from biodiesel use under the ADF, my review indicates that other elements of the staff's air quality and environmental analyses are also fundamentally flawed. These include incorrectly selecting 2014 as the baseline year for the environmental analysis, lacking documentation and using unsupported assumptions in determination of the NOx control level for biodiesel, and unnecessarily delaying the effective date for the implementation of mitigation requirements under the ADF regulation. All of these issues, which are discussed in detail in Attachment E, cause the adverse environmental impacts of the ADF regulation to be greater than purported by CARB staff.

ADF 17-21

15. Another important issue that I have identified with the ADF regulation is that it and the related LCFS and California Diesel regulations contain inconsistent and conflicting definitions and lack provisions requiring the determination, through testing, of the biodiesel content of commercial blendstocks. As a result, there is a clear potential for biodiesel blends to actually contain as much as 5% more biodiesel by volume than will be reported to CARB under the ADF regulation. A detailed discussion of the flaws in the ADF regulation that could allow this to occur is provided in Attachment F. Actual biodiesel levels above those reported under the ADF will lead to larger unmitigated increases in NOx emissions than have been estimated by either CARB staff or me.

ADF 17-22

16. CARB staff has rejected a proposed alternative to the ADF regulation submitted by Growth Energy, claiming that it will result in the same environmental benefits but be more costly than the staff proposal. As discussed in detail in Attachment G to this declaration, this finding is based on the same fundamentally flawed emissions

ADF 17-23

analysis performed by CARB staff that is discussed above. Given that the Growth Energy alternative is designed to mitigate all potential increases in NOx emissions (when assessed in light of a proper emissions analysis) due to biodiesel use under the ADF as soon as the regulation becomes effective, it yields greater and more timely environmental benefits than the staff proposal. In addition, the Growth Energy alternative would require the same mitigation techniques as the ADF regulation, but simply expands the circumstances under which they must be applied, and has an estimated cost-effectiveness equal to that of ADF regulation. Because the Growth Energy Alternative provides greater environmental benefits as cost-effectively as the ADF regulation, it must be adopted by CARB instead of the ADF regulation.

ADF 17-23 cont.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed this 17th day of February, 2015 at Sacramento, California.

JAMES M. LYONS

17_OP_ADF_GE Responses (Page 230 – 233)

113. Comment: **ADF 17-18 through 17-23**

Agency Response:
The responses to these comments are in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

114. Comment: **LCFS 46-235 through LCFS 46-LCFS 238**

Agency Response:
The responses to these comments are in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

Attachment A

Résumé

James Michael Lyons

sierra research

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Education

1985, M.S., Chemical Engineering, University of California, Los Angeles

1983, B.S., Cum Laude, Chemistry, University of California, Irvine

Professional Experience

4/91 to present — Senior Engineer/Partner/Senior Partner
Sierra Research

Primary responsibilities include oversight and execution of complex analyses of the emission benefits, costs, and cost-effectiveness of mobile source air pollution control measures. Mr. Lyons has developed particular expertise with respect to the assessment of control measures involving fuel reformulation, fuel additives, and alternative fuels, as well as accelerated vehicle/engine retirement programs, the deployment of advanced emission control systems for on- and non-road gasoline- and Diesel-powered engines, on-vehicle evaporative and refueling emission control systems, and Stage I and Stage II service station vapor recovery systems. Additional duties include assessments of the activities of federal, state, and local regulatory agencies with respect to motor vehicle emissions and reports to clients regarding those activities. Mr. Lyons has extensive litigation experience related to air quality regulations, product liability, and intellectual property issues.

7/89 to 4/91 — Senior Air Pollution Specialist
California Air Resources Board

Supervised a staff of four professionals responsible for identifying and controlling emissions of toxic air contaminants from mobile sources and determining the effects of compositional changes to gasoline and diesel fuel on emissions of regulated and unregulated pollutants. Other responsibilities included development of new test procedures and emission standards for evaporative and running loss emissions of hydrocarbons from vehicles; overseeing the development of the state plan to control toxic emissions from motor vehicles; and reducing emissions of CFCs from motor vehicles.

4/89 to 7/89 Air Pollution Research Specialist
California Air Resources Board

Responsibilities included identification of motor vehicle research needs; writing requests for proposals; preparation of technical papers and reports; as well as monitoring and overseeing research programs.

9/85 to 4/89 Associate Engineer/Engineer
California Air Resources Board

Duties included analysis of vehicle emissions data for trends and determining the effectiveness of various types of emissions control systems for both regulated and toxic emissions; determining the impact of gasoline and diesel powered vehicles on ambient levels of toxic air contaminants; participation in the development of regulations for "gray market" vehicles; and preparation of technical papers and reports.

Professional Affiliations

American Chemical Society
Society of Automotive Engineers

Selected Publications (Author or Co-Author)

"Development of Vehicle Attribute Forecasts for 2013 IEPR," Sierra Research Report No. SR2014-01-01, prepared for the California Energy Commission, January 2014.

"Assessment of the Emission Benefits of U.S. EPA's Proposed Tier 3 Motor Vehicle Emission and Fuel Standards," Sierra Research Report No. SR2013-06-01, prepared for the American Petroleum Institute, June 2013.

"Development of Inventory and Speciation Inputs for Ethanol Blends," Sierra Research Report No. SR2012-05-01, prepared for the Coordinating Research Council, Inc. (CRC), May 2012.

"Review of CARB Staff Analysis of 'Illustrative' Low Carbon Fuel Standard (LCFS) Compliance Scenarios," Sierra Research Report No. SR2012-02-01, prepared for the Western States Petroleum Association, February 20, 2012.

"Review of CARB On-Road Heavy-Duty Diesel Emissions Inventory," Sierra Research Report No. SR2010-11-01, prepared for The Ad Hoc Working Group, November 2010.

"Identification and Review of State/Federal Legislative and Regulatory Changes Required for the Introduction of New Transportation Fuels," Sierra Research Report No. SR2010-08-01, prepared for the American Petroleum Institute, August 2010.

"Technical Review of EPA Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis for Non-GHG Pollutants," Sierra Research Report No. SR2010-05-01, prepared for the American Petroleum Institute, May 2010.

"Effects of Gas Composition on Emissions from Heavy-Duty Natural Gas Engines," Sierra Research Report No. SR2010-02-01, prepared for the Southern California Gas Company, February 2010.

"Effects of Gas Composition on Emissions from a Light-Duty Natural Gas Vehicle," Sierra Research Report No. SR2009-11-01, prepared for the Southern California Gas Company, November 2009.

"Technical Review of 2009 EPA Draft Regulatory Impact Analysis for Non-GHG Pollutants Due to Changes to the Renewable Fuel Standard," Sierra Research Report No. SR2009-09-01, prepared for the American Petroleum Institute, September 2009.

"Effects of Vapor Pressure, Oxygen Content, and Temperature on CO Exhaust Emissions," Sierra Research Report No. 2009-05-03, prepared for the Coordinating Research Council, May 2009.

"Technical Review of 2007 EPA Regulatory Impact Analysis Methodology for the Renewable Fuels Standard," Sierra Research Report No. 2008-09-02, prepared for the American Petroleum Institute, September 2008.

"Impacts of MMT Use in Unleaded Gasoline on Engines, Emission Control Systems, and Emissions," Sierra Research Report No. 2008-08-01, prepared for McMillan Binch Mendelsohn LLP, Canadian Vehicle Manufacturers' Association, and Association of International Automobile Manufacturers of Canada, August 2008.

"Attachment to Comments Regarding the NHTSA Proposal for Average Fuel Economy Standards Passenger Cars and Light Trucks Model Years 2011-2015, Docket No. NHTSA-2008-0089," Sierra Research Report No. SR2008-06-01, prepared for the Alliance of Automobile Manufacturers, June 2008.

"Evaluation of California Greenhouse Gas Standards and Federal Energy Independence and Security Act – Part 1: Impacts on New Vehicle Fuel Economy," SAE Paper No. 2008-01-1852, Society of Automotive Engineers, 2008.

"Basic Analysis of the Cost and Long-Term Impact of the Energy Independence and Security Act Fuel Economy Standards," Sierra Research Report No. SR 2008-04-01, April 2008.

"The Benefits of Reducing Fuel Consumption and Greenhouse Gas Emissions from Light-Duty Vehicles," SAE Paper No. 2008-01-0684, Society of Automotive Engineers, 2008.

"Assessment of the Need for Long-Term Reduction in Consumer Product Emissions in South Coast Air Basin," Sierra Research Report No. 2007-09-03, prepared for the Consumer Specialty Products Association, September 2007.

"Summary of Federal and California Subsidies for Alternative Fuels," Sierra Research Report No. SR2007-04-02, prepared for the Western States Petroleum Association, April 2007.

"Analysis of IRTA Report on Water-Based Automotive Products," Sierra Research Report No. SR2006-08-02, prepared for the Consumer Specialty Projects Association and Automotive Specialty Products Alliance, August 2006.

"Evaluation of Pennsylvania's Implementation of California's Greenhouse Gas Regulations on Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2006-04-01, prepared for Alliance of Automobile Manufacturers, April 12, 2006.

"Evaluation of New Jersey's Adoption of California's Greenhouse Gas Regulations on Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2005-09-03, prepared for the Alliance of Automobile Manufacturers, September 30, 2005.

"Evaluation of Vermont's Adoption of California's Greenhouse Gas Regulations on Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2005-09-02, prepared for the Alliance of Automobile Manufacturers, September 19, 2005.

"Assessment of the Cost-Effectiveness of Compliance Strategies for Selected Eight-Hour Ozone NAAQS Nonattainment Areas," Sierra Research Report No. SR2005-08-04, prepared for the American Petroleum Institute, August 30, 2005.

"Evaluation of Connecticut's Adoption of California's Greenhouse Gas Regulations on Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2005-08-03, prepared for the Alliance of Automobile Manufacturers, August 26, 2005.

"Evaluation of New York's Adoption of California's Greenhouse Gas Regulations On Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2005-07-04, prepared for the Alliance of Automobile Manufacturers, July 14, 2005.

"Review of MOVES2004," Sierra Research Report No. SR2005-07-01, prepared for the Alliance of Automobile Manufacturers, July 11, 2005.

"Review of Mobile Source Air Toxics (MSAT) Emissions from On-Highway Vehicles: Literature Review, Database, Development, and Recommendations for Future Studies," Sierra Research Report No. SR2005-03-01, prepared for the American Petroleum Institute, March 4, 2005.

"The Contribution of Diesel Engines to Emissions of ROG, NOx, and PM2.5 in California: Past, Present, and Future," Sierra Research Report No. SR2005-02-01, prepared for Diesel Technology Forum, February 2005.

"Fuel Effects on Highway Mobile Source Air Toxics (MSAT) Emissions," Sierra Research Report No. SR2004-12-01, prepared for the American Petroleum Institute, December 23, 2004.

Attachment A-4

"Review of the August 2004 Proposed CARB Regulations to Control Greenhouse Gas Emissions from Motor Vehicles: Cost Effectiveness for the Vehicle Owner or Operator – Appendix C to the Comments of The Alliance of Automobile Manufacturers," Sierra Research Report No. SR2004-09-04, prepared for the Alliance of Automobile Manufacturers, September 2004.

"Emission and Economic Impacts of an Electric Forklift Mandate," Sierra Research Report No. SR2003-12-01, prepared for National Propane Gas Association, December 12, 2003.

"Reducing California's Energy Dependence," Sierra Research Report No. SR2003-11-03, prepared for Alliance of Automobile Manufacturers, November 25, 2003.

"Evaluation of Fuel Effects on Nonroad Mobile Source Air Toxics (MSAT) Emissions: Literature Review, Database Development, and Recommendations for Future Studies," Sierra Research Report No. SR2003-10-01, prepared for American Petroleum Institute, October 3, 2003.

"Review of Current and Future CO Emissions from On-Road Vehicles in Selected Western Areas," Sierra Research Report No. SR03-01-01, prepared for the Western States Petroleum Association, January 2003.

"Review of CO Compliance Status in Selected Western Areas," Sierra Research Report No. SR02-09-04, prepared for the Western States Petroleum Association, September 2002.

"Impacts Associated With the Use of MMT as an Octane Enhancing Additive in Gasoline – A Critical Review", Sierra Research Report No. SR02-07-01, prepared for Canadian Vehicle Manufacturers Association and Association of International Automobile Manufacturers of Canada, July 24, 2002.

"Critical Review of 'Safety Oversight for Mexico-Domiciled Commercial Motor Carriers, Final Programmatic Environmental Assessment', Prepared by John A Volpe Transportation Systems Center, January 2002," Sierra Research Report No. SR02-04-01, April 16, 2002.

"Critical Review of the Method Used by the South Coast Air Quality Management District to Establish the Emissions Equivalency of Heavy-Duty Diesel- and Alternatively Fueled Engines", Sierra Research Report No. SR01-12-03, prepared for Western States Petroleum Association, December 21, 2001.

"Review of U.S. EPA's Diesel Fuel Impact Model", Sierra Research Report No. SR01-10-01, prepared for American Trucking Associations, Inc., October 25, 2001.

"Operation of a Pilot Program for Voluntary Accelerated Retirement of Light-Duty Vehicles in the South Coast Air Basin," Sierra Research Report No. SR01-05-02, prepared for California Air Resources Board, May 2001.

Attachment A-5

"Comparison of Emission Characteristics of Advanced Heavy-Duty Diesel and CNG Engines," Sierra Report No. SR01-05-01, prepared for Western States Petroleum Association, May 2001.

"Analysis of Southwest Research Institute Test Data on Inboard and Sterndrive Marine Engines," Sierra Report No. SR01-01-01, prepared for National Marine Manufacturers Association, January 2001.

"Institutional Support Programs for Alternative Fuels and Alternative Fuel Vehicles in Arizona: 2000 Update," Sierra Report No. SR00-12-04, prepared for Western States Petroleum Association, December 2000.

"Real-Time Evaporative Emissions Measurement: Mid-Morning Commute and Partial Diurnal Events," SAE Paper No. 2000-01-2959, October 2000.

"Evaporative Emissions from Late-Model In-Use Vehicles," SAE Paper No. 2000-01-2958, October 2000.

"A Comparative Analysis of the Feasibility and Cost of Compliance with Potential Future Emission Standards for Heavy-Duty Vehicles Using Diesel or Natural Gas," Sierra Research Report No. SR00-02-02, prepared for Californians For a Sound Fuel Strategy, February 2000.

"Critical Review of the Report Entitled 'Economic Impacts of On Board Diagnostic Regulations (OBD II)' Prepared by Spectrum Economics," Sierra Research Report No. SR00-01-02, prepared for the Alliance of Automobile Manufacturers, January 2000.

"Potential Evaporative Emission Impacts Associated with the Introduction of Ethanol-Gasoline Blends in California," Sierra Research Report No. SR00-01-01, prepared for the American Methanol Institute, January 2000.

"Evaporative Emissions from Late-Model In-Use Vehicles," Sierra Research Report No. SR99-10-03, prepared for the Coordinating Research Council, October 1999.

"Investigation of Sulfur Sensitivity and Reversibility in Late-Model Vehicles," SAE Paper No. 1999-01-3676, August 1999.

"Future Diesel-Fueled Engine Emission Control Technologies and Their Implications for Diesel Fuel Properties," Sierra Research Report No. SR99-08-01, prepared for the American Petroleum Institute, August 1999.

"Analysis of Compliance Feasibility under Proposed Tier 2 Emission Standards for Passenger Cars and Light Trucks," Sierra Research Report No. SR99-07-02, July 1999.

"Comparison of the Properties of Jet A and Diesel Fuel," Sierra Research Report No. SR99-02-01, prepared for Pillsbury Madison and Sutro, February 1999.

"Investigation of Sulfur Sensitivity and Reversibility in Late-Model Vehicles," Sierra Research Report No. SR98-12-02, prepared for the American Petroleum Institute, December 1998.

"Analysis of New Motor Vehicle Issues in the Canadian Government's Foundation Paper on Climate Change – Transportation Sector," Sierra Research Report No. SR98-12-01, prepared for the Canadian Vehicle Manufacturers Association, December 1998.

"Investigation of the Relative Emission Sensitivities of LEV Vehicles to Gasoline Sulfur Content - Emission Control System Design and Cost Differences," Sierra Research Report No. SR98-06-01, prepared for the American Petroleum Institute, June 1998.

"Costs, Benefits, and Cost-Effectiveness of CARB's Proposed Tier 2 Regulations for Handheld Equipment Engines and a PPEMA Alternative Regulatory Proposal," Sierra Research Report No. SR98-03-03, prepared for the Portable Power Equipment Manufacturers Association, March 1998.

"Analysis of Diesel Fuel Quality Issues in Maricopa County, Arizona," Sierra Research Report No. SR97-12-03, prepared for the Western States Petroleum Association, December 1997.

"Potential Impact of Sulfur in Gasoline on Motor Vehicle Pollution Control and Monitoring Technologies," prepared for Environment Canada, July 1997.

"Analysis of Mid- and Long-Term Ozone Control Measures for Maricopa County," Sierra Research Report No. SR96-09-02, prepared for the Western States Petroleum Association, September 9, 1996.

"Technical and Policy Issues Associated with the Evaluation of Selected Mobile Source Emission Control Measures in Nevada," Sierra Research Report No. SR96-03-01, prepared for the Western States Petroleum Association, March 1996.

"Cost-Effectiveness of Stage II Vapor Recovery Systems in the Lower Fraser Valley," Sierra Research Report No. SR95-10-05, prepared for the Province of British Columbia Ministry of Environment Lands and Parks and the Greater Vancouver Regional District, October 1995.

"Cost of Stage II Vapor Recovery Systems in the Lower Fraser Valley," Sierra Research Report No. SR95-10-04, prepared for the Province of British Columbia Ministry of Environment Lands and Parks and the Greater Vancouver Regional District, October 1995.

"A Comparative Characterization of Gasoline Dispensing Facilities With and Without Vapor Recovery Systems," Sierra Research Report No. SR95-10-01, prepared for the Province of British Columbia Ministry of Environment Lands and Parks, October 1995.

"Potential Air Quality Impacts from Changes in Gasoline Composition in Arizona," Sierra Research Report No. SR95-04-01, prepared for Mobil Corporation, April 1995.

"Vehicle Scrappage: An Alternative to More Stringent New Vehicle Standards in California," Sierra Research Report No. SR95-03-02, prepared for Texaco, Inc., March 1995.

"Evaluation of CARB SIP Mobile Source Measures," Sierra Research Report No. SR94-11-02, prepared for Western States Petroleum Association, November 1994.

"Reformulated Gasoline Study," prepared by Turner, Mason & Company, DRI/McGraw-Hill, Inc., and Sierra Research, Inc., for the New York State Energy Research and Development Authority, Energy Authority Report No. 94-18, October 1994.

"Phase II Feasibility Study: Heavy-Duty Vehicle Emissions Inspection Program in the Lower Fraser Valley," Sierra Research Report No. SR94-09-02, prepared for the Greater Vancouver Regional District, September 1994.

"Cost-Effectiveness of Mobile Source Emission Controls from Accelerated Scrappage to Zero Emission Vehicles," Paper No. 94-TP53.05, presented at the 87th Annual Meeting of the Air and Waste Management Association, Cincinnati, OH, June 1994.

"Investigation of MOBILE5a Emission Factors, Assessment of I/M Program and LEV Program Emission Benefits," Sierra Research Report No. SR94-06-05, prepared for American Petroleum Institute, June 1994.

"Cost-Effectiveness of the California Low Emission Vehicle Standards," SAE Paper No. 940471, 1994.

"Meeting ZEV Emission Limits Without ZEVs," Sierra Research Report No. SR94-05-06, prepared for Western States Petroleum Association, May 1994.

"Evaluating the Benefits of Air Pollution Control - Method Development and Application to Refueling and Evaporative Emissions Control," Sierra Research Report No. SR94-03-01, prepared for the American Automobile Manufacturers Association, March 1994.

"The Cost-Effectiveness of Further Regulating Mobile Source Emissions," Sierra Research Report No. SR94-02-04, prepared for the American Automobile Manufacturers Association, February 1994.

"Searles Valley Air Quality Study (SVAQS) Final Report," Sierra Research Report No. SR94-02-01, prepared for North American Chemical Company, February 1994.

"A Comparative Study of the Effectiveness of Stage II Refueling Controls and Onboard Refueling Vapor Recovery," Sierra Research Report No. SR93-10-01, prepared for the American Automobile Manufacturers Association, October 1993.

"Evaluation of the Impact of the Proposed Pole Line Road Overcrossing on Ambient Levels of Selected Pollutants at the Calgene Facilities," Sierra Research Report No. SR93-09-01, prepared for the City of Davis, September 1993.

"Leveling the Playing Field for Hybrid Electric Vehicles: Proposed Modifications to CARB's LEV Regulations," Sierra Research Report No. SR93-06-01, prepared for the Hybrid Vehicle Coalition, June 1993.

"Size Distributions of Trace Metals in the Los Angeles Atmosphere," *Atmospheric Environment*, Vol. 27B, No. 2, pp. 237-249, 1993.

"Preliminary Feasibility Study for a Heavy-Duty Vehicle Emissions Inspection Program in the Lower Fraser Valley Area," Sierra Research Report No. 92-10-01, prepared for the Greater Vancouver Regional District, October 1992.

"Development of Mechanic Qualification Requirements for a Centralized I/M Program," SAE Paper No. 911670, 1991.

"Cost-Effectiveness Analysis of CARB's Proposed Phase 2 Gasoline Regulations," Sierra Research Report No. SR91-11-01, prepared for the Western States Petroleum Association, November 1991.

"Origins and Control of Particulate Air Toxics: Beyond Gas Cleaning," in Proceedings of the Twelfth Conference on Cooperative Advances in Chemical Science and Technology, Washington, D.C., October 1990.

"The Effect of Gasoline Aromatics on Exhaust Emissions: A Cooperative Test Program," SAE Paper No. 902073, 1990.

"Estimation of the Impact of Motor Vehicles on Ambient Asbestos Levels in the South Coast Air Basin," Paper No. 89-34B.7, presented at the 82nd Annual Meeting of the Air and Waste Management Association, Anaheim, CA, June 1989.

"Benzene/Aromatic Measurements and Exhaust Emissions from Gasoline Vehicles," Paper No. 89-34B.4, presented at the 82nd Annual Meeting of the Air and Waste Management Association, Anaheim, CA, June 1989.

"The Impact of Diesel Vehicles on Air Pollution," presented at the 12th North American Motor Vehicle Emissions Control Conference, Louisville, KY, April 1988.

"Exhaust Benzene Emissions from Three-Way Catalyst-Equipped Light-Duty Vehicles," Paper No. 87-1.3, presented at the 80th Annual Meeting of the Air Pollution Control Association, New York, NY, June 1987.

"Trends in Emissions Control Technologies for 1983-1987 Model-Year California-Certified Light-Duty Vehicles," SAE Paper No. 872164, 1987.

17_OP_ADF_GE Responses (Page 234 – 242)

115. Comment: **James Lyons' Resume**

Agency Response:
This is submittal one of three, of James Lyons' resume to the ADF docket. It does not constitute an objection or suggestion on the proposal.

Attachment B

Review of CARB Staff's Analysis of the GHG and Air Quality Impacts of the LCFS Regulation

In developing the proposed Low Carbon Fuel Standard (LCFS) regulation for re-adoption, CARB staff purports to have performed an analysis of the impacts that the regulation will have on emissions of both greenhouse gases and air pollutants. However, as is documented below, a review the CARB analysis demonstrates that the staff's analysis is incomplete and unsuitable for use in determining whether or not all adverse impacts have been identified and properly quantified, and all mitigation measures have been appropriately considered.

Summary of the CARB Staff Air Quality Analysis

On December 30, 2014, CARB staff released the proposed LCFS regulation language and the accompanying Initial Statement of Reasons (ISOR), Draft Environmental Analysis, and other supporting documents. Staff's analysis of the impact of the LCFS proposed for re-adoption is contained in Chapter IV of the ISOR as well as in Chapter 4.3. of the Draft Environmental Analysis.

LCFS 46-239

In Table IV-2 of Chapter IV of the ISOR, CARB staff provides unsupported estimates of the reduction in GHG emissions associated with the LCFS regulation proposed for re-adoption. However, by CARB staff's own admission, the estimates presented in Table IV-2:

> *…do not include a reduction to eliminate the double counting of the Zero Emission Vehicle mandate, the federal Renewable Fuels Standard program, the Pavley standards, or the federal Corporate Average Fuel Economy program.*

Given that CARB staff has failed to estimate and report the GHG reduction benefits of the LCFS regulation proposed for re-adoption separately from other regulations that also seek to reduce GHG emissions from mobile sources, the Board and the public do not know the actual benefits expected to result from the regulation nor can alternatives to the LCFS regulation be properly evaluated by CARB staff.

LCFS 46-240

Turning to the air quality analysis in Chapter IV of the ISOR, CARB staff provides a general discussion of emissions associated with transportation fuel production at California refineries, as well as ethanol, biodiesel, renewable diesel, and potential cellulosic ethanol facilities. Emission factors in, terms of pollutant emissions per year per million gallons of fuel produced, are provided for some facilities. CARB staff also provides an undocumented analysis of NOx and $PM_{2.5}$ emissions associated with "*...the movement of fuel and feedstock in heavy-duty diesel trucks and railcars"* with and

LCFS 46-241

without the LCFS and ADF regulations in place. No other assessment of the air quality impacts associated with the LCFS is provided in the LCFS ISOR.

LCFS 46-241 cont.

As noted above, the draft Environmental Analysis (EA) for the LCFS and ADF, which is Appendix D to both the LCFS and ADF ISORs, also addresses air quality in Chapter 4.3. Here, short term air quality impacts related to the construction of projects of various types related to the production and distribution of lower carbon intensity fuels under the LCFS are presented. There is, however, no analysis that indicates where these projects will be located within California, nor any quantitative assessment of the emission and environmental impacts beyond the following:

> *Based on typical emission rates and other parameters for abovementioned equipment and activities, construction activities could result in hundreds of pounds of daily NO_x and PM emissions, which may exceed general mass emissions limits of a local or regional air quality management district depending on the location of generation. Thus, implementation of new regulations and/or incentives could generate levels that conflict with applicable air quality plans, exceed or contribute substantially to an existing or projected exceedance of State or national ambient air quality standards, or expose sensitive receptors to substantial pollutant concentrations.*

LCFS 46-242

There is also a general discussion of potential approaches to mitigation, which CARB staff concludes are outside of the agency's authority to adopt. Ultimately, the draft EA concludes that the "short-term construction-related air quality impacts…associated with the proposed LCFS and ADF regulations would be potentially significant and unavoidable."

LCFS 46-243

The draft EA also purports to assess the long-term impacts of the LCFS and ADF regulations, but addresses and attempts to quantify only potential increases in NOx emissions due to the use of biodiesel fuels, and concludes with CARB staff ultimately claiming that the long term impacts of the LCFS and ADF on air quality will be "beneficial."

LCFS 46-244

Review of the CARB Staff Air Quality Analysis

As summarized above, the air quality related analyses performed by CARB staff regarding the proposed LCFS regulation are both limited and cursory. In order to demonstrate that this is in fact the case, one has to look no further than the air quality analysis CARB staff performed in 2009 to support the original LCFS rulemaking.[1]

LCFS 46-245

[1] California Air Resources Board, Proposed Regulation to Implement the Low Carbon Fuel Standard, Volume I: Staff Report: Initial Statement of Reasons, March 5, 2009 and Volume II: Appendices, March 5, 2009. See in particular, Chapter VII of the ISOR and Appendix F.

The first point of note is that in the 2009 ISOR, CARB staff presents quantification of the GHG reductions expected from the LCFS occurring both in California and worldwide in Tables VII-1 and VII-2. While, those estimates have no relevance to the current rulemaking given the differences in the two regulations, fundamental changes in CARB's expectations with respect to how fuel producers will comply with a LCFS regulations, as well as the evolution of methodologies for estimating GHG emissions, provide clear evidence that the GHG emission benefits of the proposed LCFS can and should be explicitly quantified without any "double counting" of the benefits due to other regulatory programs. It should also be noted that in the 2009 ISOR, CARB staff also breaks down the GHG emission benefits expected from specific substitutes for gasoline and diesel fuel.

LCFS 46-246

Turning to the air quality analysis itself, the lack of documentation provided precludes any detailed review of the accuracy of the assumptions and methodologies underlying the analysis or any effort to attempt to reproduce the staff's results. Given this lack of documentation, additional information was requested from CARB. As part of this request, Sierra Research pointed out that pursuant to the requirements of AB 1085, the agency had provided far more detailed information for other recent major rulemakings, including the Advanced Clean Cars program, than it released regarding the LCFS and ADF proposals. Unfortunately, CARB staff choose not to provide any additional information related to the analyses underlying the proposed LCFS and ADF regulations.

LCFS 46-247

Another striking contrast which highlights the superficiality of the air quality analysis performed for the re-adoption of the LCFS can be seen in the treatment of potential emission impacts associated with the development of biofuel production facilities in California. These impacts are particularly important because the form of the LCFS regulation provides incentives to build biofuel production facilities in areas of California that violate federal National Ambient Air Quality standards, rather than in other states that are in compliance with those standards. The incentive for locating biofuel plants in California is to avoid GHG emissions from fuel and/or feed stock transportation which result in higher carbon intensity values.

LCFS 46-248

As noted above, the air quality analysis for the re-adoption of the LCFS presented in section IV of the ISOR provides only estimates for existing California biofuel production facilities and the potential emissions of NO_x, PM_{10}, and volatile organic compounds (VOCs) associated with a hypothetical "northern California" cellulosic ethanol plant. In contrast, in the 2009 ISOR, staff provides a quantitative estimate of the overall number and types of new biofuel production facilities expected to be built in California (Table VII-6 of the 2009 ISOR) as well as a distribution of the number and type of plants expected to be built in eight of the state's air basins and a map showing expected locations. The increases in emissions of not only NO_x, PM_{10}, and VOC, but also carbon monoxide (CO) and $PM_{2.5}$ associated with these biodiesel production facilities were quantified by CARB staff (Table V11-10 of the 2009 ISOR). Again, although the data presented in the 2009 LCFS ISOR are irrelevant with respect to the current re-adoption of the LCFS regulation, the same level of detail and scope of the analysis performed by CARB staff in 2009 should have at a minimum been applied to the current LCFS air quality analysis.

LCFS 46-249

Another issue noted with the air quality analysis performed for the re-adoption of the LCFS is related to emission impacts associated with "fuel and feedstock transportation and distribution."

LCFS 46-250

Attachment B-3

The total impact of the LCFS and ADF on NOx and $PM_{2.5}$ emissions from these activities, which constitute a long term operational impact on air quality, are quantified in Table IV-16 of the ISOR. However, the documentation provided describing how the staff's analysis was performed is insufficient to allow one to either review or reproduce it. Further, these emissions are not addressed in the appropriate section of the draft EA. Given that staff estimates that the LCFS/ADF will increase these emissions, they should be identified and assessed as part of the draft EA, particularly given that staff has concluded that the LCFS/ADF impacts on long term air quality are beneficial without considering fuel and feedstock transportation and distribution emissions. The current analysis of these emissions also falls far short of the level of detail shown in the analysis of the same issue performed by CARB staff in the 2009 ISOR, as can be seen in Table VII-11 where impacts on VOC, CO, PM_{10}, and oxides of sulfur (SO_x) were reported by low CI fuel type.

LCFS 46-250 cont.

Again, as noted above, the only issue addressed with respect to long term LCFS/ADF air quality impacts in the draft EA are potential NOx emission increases due to the use of biodiesel blends. As discussed in detail elsewhere,[2] the analysis upon which the draft EA and its conclusions are based is fundamentally flawed. However, the air quality analysis in the draft EA is also incomplete in that it fails to address long term changes in motor vehicle emissions beyond those associated with biodiesel and renewable diesel. That such impacts should have been addressed for the current rulemaking can be seen from the CARB staff air quality analysis included in the 2009 ISOR and presentation, which included detailed estimates of motor vehicle impacts on VOC, CO, NOx, SOx, PM_{10}, and $PM_{2.5}$ (rather than just NOx and $PM_{2.5}$) as a function of vehicle and fuel type in Table VII-12.

LCFS 46-251

LCFS 46-252

In addition to the above, two other important issues are: 1) CARB staff's failure to even attempt to quantify construction emissions associated with biofuel production facilities in California after finding them to be potentially significant and unavoidable; and 2) to identify and quantify potential emission increases associated with an increase in the number of tanker visits to California ports as the result of the ADF and LCFS regulations. With respect to the former, a California specific tool, CalEEmod,[3] is readily available that could have been used by CARB staff in estimating construction impacts form biofuel plants located in California.

LCFS 46-253

LCFS 46-254

With respect to the latter, it should be noted that although CARB staff concluded in the 2009 LCFS air quality analysis that there would be "little to no change to emissions at ports," that analysis predates the current proposal[4] regarding the assignment of CI to crude oil which are likely to encourage crude oil shuffling; as well as CARB staff assumptions regarding increases in assumed volumes of renewable diesel fuel potentially coming to California from production facilities in Asia, and the potential for direct importation of cane ethanol into California from Brazil. These factors will undoubtedly result in increased tanker operations in California waters the emission impacts of which can be estimated using the Emissions Estimation Methodology for Ocean-Going Vessels available on CARB's emission inventory website. According to this source, 1,919 visits by crude oil and petroleum product tankers are forecast for 2015 with roughly 50% percent of those trips involving southern California ports that are part of the South

LCFS 46-255

[2] Declaration of James M. Lyons filed as comments to the ADF regulation.
[3] California Emissions Estimator Model, Users Guide, Version 2013.2, July 2013.
[4] See proposed section 95489, Title 17 CCR in LCFS ISOR Appendix A.

Coast air basin. The emissions estimated by CARB to be associated with one tanker visit to California are presented in Table 1. As shown, the tanker emissions associated with a single new visit far exceed the NOx, $PM_{2.5}$ and SOx significance thresholds. Given that multiple new tanker visits are likely to result from the LCFS and ADF regulations, these values demonstrate that CARB staff has failed to identify a potentially significant source that will created adverse air quality impacts in its draft EA.

LCFS 46-255 cont.

Table 1
Comparison of Tanker Emissions During A Single Visit to California with South Coast Air Quality Management District Air Quality Significance Thresholds

Pollutant	Significance Threshold (lbs/day)	Tanker Emissions (lbs)
NOx	55	7,700
VOC	55	283
PM_{10}	150	290
$PM_{2.5}$	55	283
SOx	150	1,780
CO	550	629

17_OP_ADF_GE Responses (Page 243 – 247)

116. Comment: **LCFS 46-239 through LCFS 46-255**

Agency Response:
The responses to these comments are in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

Attachment C

The Growth Energy Alternative to the Proposed LCFS Regulation is the Least-Burdensome Approach that Best Achieves the Project Objectives at the Least Cost That Must be Adopted

As part of the rulemaking process leading to CARB staff's proposed re-adoption of the LCFS regulation, staff was required to solicit and consider alternatives to the proposed regulation. Growth Energy submitted such an alternative. While CARB staff acknowledged that the Growth Energy alternative could provide equivalent reductions in GHG emissions, the agency rejected it from further consideration or analysis by stating only that it was insufficient to transition California to alternative, lower carbon intensity fuels. As discussed below, CARB staff's premise for rejecting the Growth Energy alternative is incorrect. Further, given that the Growth Energy Alternative achieves the same environmental benefits through reductions in GHG emissions as the LCFS regulation, likely at the same or lower cost, it should have been analyzed by CARB staff, in which case it would have to be adopted as the least-burdensome approach the best achieves the project objectives at the least cost.

LCFS 46-256

Background

On May 23, 2014, CARB published a "Solicitation of Alternatives for Analysis in the LCFS Standardized Regulatory Impact Assessment" which is attached. On June 5, CARB published a response to a request from Growth Energy extending the deadline for the submission of alternatives from June 5, 2014 to June 23, 2014. On June 23, 2014, Growth Energy submitted an alternative regulatory proposal for the LCFS regulation (which is attached) to CARB in response to the agency's solicitation. On December 30, 2014, CARB staff published both the ISOR for the LCFS regulation as well as a document entitled "Summary of DOF Comments to the Combined LCFS/ADF SRIA and ARB Responses," which is Appendix E to the LCFS ISOR. Appendix E discusses the Growth Energy LCFS alternative and CARB's reason for its rejection.

LCFS 46-257

The staff's assessment of the Growth Energy (GE) Alternative published in Appendix E of the LCFS ISOR is as follows (emphasis added):

> *The proposed alternative assumes that the exclusive goal of the LCFS proposal is to achieve GHG emissions reductions without regard to source. If that were the case, this would be a viable alternative to the LCFS and would be assessed in this analysis. It is likely true that the estimated GHG emissions reductions appearing in the 2009 LCFS Initial Statement of Reasons (California Air Resources Board, 2009) could be achieved by the AB 32 Cap-and-Trade Program, along with the other programs cited by Sierra Research and Growth Energy. The LCFS proposal, however, was designed to address the carbon intensity of transportation*

fuels. Transportation in California was powered almost completely by petroleum fuels in 2010. Those fuels were extracted, refined, and distributed through an extensive and mature infrastructure. Transitioning California to alternative, lower-carbon fuels requires a very focused and sustained regulatory program tailored to that goal. The other regulatory schemes the alternative would rely on are comparatively "blunt instruments" less likely to yield the innovations fostered by the LCFS proposal. In the absence of such a program, post-2020 emissions reductions would have to come from a transportation sector that would, in all likelihood, have emerged from the 2010-2020 decade relatively unchanged.

In the absence of an LCFS designed to begin the process of transitioning the California transportation sector to lower-carbon fuels starting in 2010, post-2020 reductions would be difficult and costly to achieve. This is why the primary goals of the LCFS are to reduce the carbon intensity of California fuels, and to diversify the fuel pool. A transportation sector that achieves these goals by 2020 will be much better positioned to achieve significant GHG emissions reductions post 2020.

ARB is required to analyze only those alternatives that are reasonable and that meet the goals of the program as required by statute. An initial assessment of the program indicates the goals of the LCFS proposal can be achieved by keeping the program "…separate of the AB 32 Cap-and-Trade system initially (at least first 10 years) in order to stimulate innovation and investment in low-GWI [global warming intensity] fuel (or transportation) technologies."[16] Due to the strong justifications that the Cap-and-Trade program alone generates neither the CI reductions nor fuel in the transportation sector, this alternative will not be assessed in this document.

LCFS 46-257 cont.

Reference 16 in the above citation is given as:

A Low-Carbon Fuel Standard for California, Part 2: Policy Analysis – FINAL REPORT, University of California Project Managers: Alexander E. Farrell, UC Berkeley; Daniel Sperling, UC Davis. Accessed: 7-15-2015
http://www.energy.ca.gov/low_carbon_fuel_standard/

Discussion

Given that there is no analysis or other support provided by CARB staff for the assertions it makes in rejecting the Growth Energy alternative other than the one reference, which dates to 2007—before either the original LCFS or Cap-and-Trade regulation were adopted was reviewed. The discussion of interactions between a LCFS program with AB32 regulations from the reference is provided below. As can be determined by the reader, the discussion was written before the AB32 regulations were adopted, and the basic concern expressed is that the lower cost of achieving the same GHG reductions from a broader program will be lower than the cost of doing the same from the LCFS

LCFS 46-258

program. Further, the concern expressed regarding lifecycle emission under the LCFS was explicitly addressed in the Growth Energy alternative.

5.2 Interactions with AB32 regulations

RECOMMENDATION 16: The design of both the LCFS and AB32 polices must be coordinated and it is not possible to specify one without the other. However, it is clear that if the AB32 program includes a hard cap, the intensity-based LCFS must be separate or the cap will be meaningless. Including the transport sector in both the AB32 regulatory program and LCFS will provide complementary incentives and is feasible. CARB will soon be developing regulations under AB32 to control GHG emissions broadly across the economy, most likely through a cap-and-trade system plus a set of regulatory policies. Thus, emissions from electricity generation, oil production, refining, and biofuel production are likely to be regulated directly under AB32. These energy production emissions are "upstream" in a fuel's life cycle (while emissions from a vehicle are "downstream"). The recent Market Advisory Committee report recommends including all CO2 emissions from transportation, including tailpipe emissions.

LCFS 46-258

The LCFS regulates consumption emissions—the full life cycle emissions associated with products consumed in California, while it is expected that sector-specific emission caps will be imposed by AB 32 on production emissions—the emissions that are directly emitted within the borders of the state. The different types of boundaries used by these regulations causes certain upstream emissions to be double regulated under the LCFS and AB32. However, the potential for double regulation only applies to fuel production processes in the state of California or other jurisdictions where legislation similar to AB 32 also applies. We agree with the Market Advisory Committee that the LCFS and AB32 regulations will provide complementary incentives and that transportation emissions of GHGs should be included in the AB32 program.

There is no inherent conflict between the LCFS and AB32 caps; both are aimed at reducing GHG emissions and stimulating innovation in low-carbon technologies and processes. However, there are some differences. Most importantly, the LCFS is designed to stimulate technological innovation in the transportation sector specifically, while the broader AB32 program will stimulate technological innovation more broadly. The concerns associated with market failures and other barriers to technological change in the transportation sector (discussed in Section 1.3 of Part 1 and Section 2.3 of Part 2) are the motivation for adopting the sector-specific LCFS. These concerns suggest separating the LCFS from the AB32 emission caps.

The second key difference is that as a product standard using a lifecycle approach, the LCFS includes emissions that occur outside of the state such as

those associated with biofuel feedstock production and the production of imported crude oil. These emissions will not be included in the AB32 regulations.

The third difference is in expected costs. In the absence of transaction costs and other market imperfections, economic theory suggests that a broader cap-and-trade program will be less costly than a narrower one. By allowing more sectors and more firms to participate in a market for emission reductions, one reduces the cost to achieve a given level of emission reductions -- suggesting that the LCFS be linked to the broader AB 32 regulatory system. In addition, commercially available low-carbon options exist in the electricity and other sectors, but not in transportation fuels (see Part 1 of this study, Section 1.3).

The specific regulations and market mechanisms used to implement AB32 are not yet determined, so it is not possible at this time to specify how the LCFS should interact with them. The ARB should carefully consider the differences in incentives and constraints that the combination of rules will create.

LCFS 46-258 cont.

Returning to the issue of diversification of the transportation fuel sector, CARB concerns are directly refuted by Growth Energy's submission. As noted on pages 9 and 10, ethanol will be added to California gasoline, and renewable diesel and biodiesel will be blended into California diesel fuel as the result of the federal RFS program. The range of fuels and feedstocks from which they are produced under the RFS will be diverse. For example, the following fuel/feedstock pathways, among others, are currently recognized by U.S. EPA under the RFS:[1,2,3,4,5]

- Ethanol from
  - Corn
  - Sugar cane
  - Grain sorghum
  - Celluosic materials
- Biodiesel from
  - Camelina oil
  - Soy bean oil
  - Waste oils, fats and greases
  - Corn oil
  - Canola/rapseed oil
- Renewable diesel from
  - Waste oils, fats and greases

LCFS 46-259

[1] EPA-420-F-13-014
[2] EPA-420-F-14-045
[3] EPA-420-F-12-078
[4] EPA-420-F-11-043
[5] EPA-420-F-10-007

- Renewable gasoline from
    - Crop residue and municipal solid waste

- Renewable natural gas from
    - Landfills
    - Digesters

LCFS 46-259 cont.

As can be seen from Appendix B to the LCFS ISOR, these are many of the fuels that CARB staff also expects to be used in California under the LCFS. Similarly, electricity and hydrogen will be used as transportation fuels in California given the states regulatory mandates for the production of vehicles that operate on these fuels under the Advanced Clean Cars program. Further, in later years these fuels are expected to be required in heavy-duty vehicles as CARB adopts regulations under its proposed Sustainable Freight Transport Initiative, the purpose of which is stated by CARB staff as follows:

> *The purpose of the Strategy is to identify and prioritize actions to move California towards a sustainable freight transport system that is characterized by improved efficiency, zero or near-zero emissions, and increased competitiveness of the logistics system.*

It should also be noted that fuel providers in California will still be incentivized to provide these fuels in California under the Growth Energy alternative in order to reduce the number of GHG credits they will be required to retire under cap-and-trade program.

LCFS 46-260

Finally, on pages 15 and 16, Growth Energy's proposal for addressing the loss of upstream emission benefits from the LCFS regulation is explicitly discussed.

Given that the Growth Energy alternative:

1. Provides, as determined by CARB staff, the same GHG reductions as the LCFS regulation; and

2. Is expected to result in lower costs of compliance than the LCFS.

CARB must adopt the Growth Energy alternative as it better achieves the stated project objectives in an equally cost-effective manner.

17_OP_ADF_GE Responses (Page 248 – 252)

117. Comment: **LCFS 46-257 through LCFS 46-260**

Agency Response:
The responses to these comments are in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

118. Comment: **LCFS 46-256**

Agency Response:
The response to this comment is in the Low Carbon Fuel Standard Regulation Final Statement of Reasons under Comment Letter **46_OP_LCFS_GE**.

Attachment D

Review of CARB Staff Estimates of NOx Emission Increases Associated with the Use of Biodiesel in California Under the Proposed ADF Regulation

In developing the proposed Alternative Diesel Fuel (ADF) regulation, CARB staff has performed a statewide analysis of the increase in NOx emissions that is currently occurring in California due to the use of biodiesel, as well as the increases in NOx emissions that can be expected in the future due to the continued use of biodiesel in California under the proposed ADF regulation. As documented below, a review of the CARB staff analysis performed by Sierra Research demonstrates that the staff's analysis is fatally flawed and cannot be relied upon. Given this, Sierra Research has performed an analysis, also documented below, that demonstrates there will be substantial increases in NOx emissions if the ADF regulation is implemented as proposed. The significance in the NOx emissions increase associated with the use of biodiesel under the proposed ADF is clear given the dramatic reductions which CARB, the South Coast Air Quality Management District, and the San Joaquin Air Pollution Control District are seeking given their "extreme" non-compliance status with respect to the federal National Ambient Air Quality Standard for ozone.[1] This significance is also reinforced by a comparison of the estimated increase in NOx emissions from biodiesel under the proposed ADF regulation with the benefits of proposed and adopted NOx control measures intended for implementation on a statewide basis as well as in the South Coast and San Joaquin Valley air basins, respectively.

ADF 17-24

Review of the CARB Staff Analysis

On December 30, 2014, CARB staff released the proposed ADF regulation language and the accompanying Initial Statement of Reasons (ISOR), technical and economic support information, and draft environmental analysis. Staff's analysis of the impact of the proposed ADF regulation on NOx emissions and supporting information and assumptions are contained in Chapters 6 and 7 of the ISOR, as well as Appendix B entitled "Technical Supporting Information."

The first issue that was identified with the staff's emissions analysis is that the information and data supplied by CARB staff are insufficient to determine exactly how the analysis was performed. Specifically, CARB staff provides no source for the values in Table B-1 labeled "Emission Inventory (Diesel TPD)," which are key to the analysis. As illustrated below, a clear understanding of what diesel sources (e.g., on-road heavy-duty, non-road, marine, locomotives, etc.) are included in the "inventory" is critical to assessing the accuracy of the staff's analysis.

ADF 17-25

[1] It should be noted that the CARB statewide analysis fails to provide any estimate of the impacts of increased NOx emissions from the ADF regulation in these air basins, where the agency has stated that massive reductions in NOx emissions are required to achieve compliance with federal air quality standards.

Given the lack of documentation regarding the source of the diesel emission inventory values, additional information regarding this analysis as well as other analyses associated with the ADF and Low Carbon Fuel Standard (LCFS) rulemakings was requested. As part of this request, Sierra Research pointed out that pursuant to the requirements of AB 1085, the agency had provided far more detailed information for other recent major rulemakings, including the Advanced Clean Cars program, than it released regarding the LCFS and ADF proposals. Unfortunately, CARB staff choose not to provide any additional information related to the analyses underlying the proposed LCFS and ADF regulations.[2]

Despite the lack of all the information necessary to fully review the CARB staff analysis, it was possible to discern some key assumptions and the general methodology that was applied. The following key assumptions were identified:

1. Actual biodiesel use and the total demand for diesel fuel and substitutes in California will exactly match that forecast by CARB staff in the "illustrative compliance scenarios" developed as part the LCFS rulemaking;[3]

2. Actual renewable diesel use in California will exactly match that forecast by CARB staff in the "illustrative compliance scenarios" developed as part the LCFS rulemaking;[2]

3. Forty percent of renewable diesel delivered to California will be used directly by refiners to comply with the requirements of CARB's existing diesel fuel regulations[4] while the remaining 60% will be blended into fuel that complies with the diesel fuel regulations downstream of refineries;

4. The use of biodiesel up to the B20 level in New Technology Diesel Engines[5] (NTDEs, which employ exhaust aftertreatment systems to reduce NOx emissions) will not result in any increase in NOx emissions;

5. The use of biodiesel in heavy-duty diesel engines other than NTDEs—which are referred to by CARB staff as "legacy vehicles"—will increase NOx linearly with increasing biodiesel blend content, up to a 20% increase for B100;

ADF 17-26

[2] See attached emails from Jim Lyons of Sierra to Lex Mitchel and other CARB staff from January 2015.
[3] These are presented in Appendix B to the LCFS ISOR.
[4] Sections 2281 to 2284, Title 13, California Code of Regulations.
[5] Proposed section 2293.3 Title 13 CCR (see Appendix A to the LCFS ISOR) defines a New Technology Diesel Engines as:

a diesel engine that meets at least one of the following criteria:

(A) Meets 2010 ARB emission standards for on-road heavy duty diesel engines under section 1956.8.

(B) Meets Tier 4 emission standards for non-road compression ignition engines under sections 2421, 2423, 2424, 2425, 2425.1, 2426, and 2427.

(C) Is equipped with or employs a Diesel Emissions Control Strategy (DECS), verified by ARB pursuant to section 2700 et seq., which uses selective catalytic reduction to control Oxides of Nitrogen (NOx).

6. The blending of renewable diesel downstream of refineries will reduce NOx emissions from legacy vehicles, with each 2.75 gallons of renewable diesel blended offsetting the emissions increase associated with each gallon of biodiesel used; and

7. During the period from 2018 to 2020, 30 million gallons of biodiesel will be blended to the B20 level for use in legacy vehicles each year, and will therefore be subject to the mitigation requirements of the proposed ADF regulation and will not cause an increase in NOx emissions. Furthermore, this volume will increase to 35 million gallons per year from 2021 to 2023.

Based on the above assumptions, CARB staff followed the methodology steps outlined below for estimating biodiesel impacts.

1. The fraction of legacy vehicles in a given year is determined by subtracting the percentage of vehicle miles traveled by on-road heavy-duty vehicles with NTDEs from 100%.

2. The fraction of legacy vehicles from Step 1 is multiplied by the total volume of biodiesel assumed to be consumed in a given year to yield the number of gallons of biodiesel used in legacy vehicles in that year.

3. For years 2018 and later, the amount of biodiesel assumed to be sold as emissions-mitigated B20 in a given year is subtracted from the total volume of biodiesel used in legacy vehicles in that year.

4. The total volume of renewable diesel assumed to be sold in a given year is multiplied by the percentage of legacy vehicles in that year and then multiplied by 0.6 to account for renewable diesel used in refineries to yield the amount of renewable diesel creating reductions in NOx emissions from legacy vehicles in that year.

5. The amount of renewable diesel used in legacy vehicles is then divided by 2.75 to determine the number of gallons of biodiesel for which NOx emissions have been offset for that year.

6. The number of gallons of biodiesel for which NOx emissions have been offset, as determined in Step 5, is then subtracted from the amount of biodiesel used in legacy vehicles, as determined in Step 3, to yield the total number of gallons of biodiesel used in legacy vehicles that cause increased NOx emissions for that given year.

7. The biodiesel volume from Step 6 is multiplied by the assumed NOx increase of 20% for B100 and then divided by the total volume of diesel fuel forecast to be used in that year to get the percentage increase in diesel emissions for that year.

ADF 17-26 cont.

Attachment D-3

8. The value from Step 7 is multiplied by the assumed Diesel Emissions inventory for that year to yield the final estimate of increased NOx emissions due to biodiesel in units of tons per day for the entire state of California.

ADF 17-26 cont.

Using the above methodology, CARB staff estimates that use of biodiesel in California led to a 1.36 ton per day increase in NOx emissions in 2014, and that the proposed ADF regulation will reduce the magnitude of that increase through 2023 down to 0.01 ton per day.[6]

The review of the staff's emission analysis identified two major issues in addition to the lack of documentation regarding how the diesel "Emission Inventory" values used by staff were developed:

1. Assuming that biodiesel use in NTDEs at levels up to B20 will not increase NOx emissions; and

ADF 17-27

2. Assuming that biodiesel NOx emissions are offset by the use of renewable diesel fuel.

ADF 17-28

Beginning with NTDEs, it has been demonstrated[7] that the available data indicate not only that NOx emissions from NTDEs will increase with the use of biodiesel in proportion to the amount of biodiesel present in the blend, but also that the magnitude of the increase on a percentage basis will be much greater than that observed for "legacy vehicles." At the B20 level where CARB staff assumed that there will be no NOx increase, the best current estimate is that NTDE NOx emissions will be increased by between 18% and 22%. CARB staff's failure to account for increased NOx emissions from NTDEs renders the staff's emission analysis meaningless in terms of assessing the adverse environmental impacts of the proposed ADF regulation. Another problem with CARB staff's treatment of NTDEs is that they have incorrectly assumed that the penetration of NTDEs into the on-road fleet is equal to that in the non-road fleet. NTDE penetration rates into the non-road fleet will be delayed due to the later effective date of the Tier 4 Final standards, relative to the 2010 on-road standards, and by the fact that while newer trucks dominate on-road heavy-duty vehicle operation, that effect does not occur in the non-road vehicle population.

ADF 17-27 cont.

Similarly, there are fundamental flaws with CARB staff's assumption that the use of renewable diesel will offset increased NOx emissions due to the use of biodiesel. First, it must be noted that there is nothing in either the proposed ADF regulation or the proposed LCFS regulation that mandates the use of any volume of biodiesel in California, much less the use of the exact ratio of renewable diesel to biodiesel assumed by CARB staff in its emissions analysis. Second, based on a review of the ADF and LCFS ISORs and supporting materials, there is no apparent basis for the staff's assumption that 40% of renewable diesel used in California will be used by refiners to aid in compliance with CARB's existing diesel fuel regulations, and that 60% will be blended downstream of refineries. To the extent that fuel producers choose to blend renewable diesel in California, one would expect them to do so by purchasing renewable diesel for use at their

ADF 17-28 cont.

[6] Table B-1, Appendix B of the ADF ISOR.
[7] "NOx Emission Impacts of Biodiesel Blends," Rincon Ranch Consulting, February 17, 2015.

refineries where they can benefit from the other desirable properties of this fuel beyond its low carbon intensity (CI) value (e.g., high cetane number and fungibility with diesel fuel at all blend levels), rather than by purchasing LCFS credits generated by downstream blenders of renewable diesel fuel.

ADF 17-28 cont.

To illustrate the magnitude of the significance of CARB's flawed assumptions regarding NTDEs and renewable diesel, if one simply and extremely conservatively assumes that NTDE NOx increases will be the same on a percentage basis as legacy vehicles and eliminates the NOx offsets assumed from renewable diesel, the NOx increases expected from biodiesel increase from 1.35 tons per day statewide in 2014 to approximately 3.44 tons per day—a factor of about 2.65. For 2023, estimated NOx emission increases due to biodiesel rise to about 0.87 tons per day, or about 100 times more than the 0.01 tons per day CARB staff estimated. However, as documented below, a more rigorous analysis indicates that far greater increases in NOx emissions are likely.

ADF 17-29

Detailed Analysis of Increases in NOx Emissions from Biodiesel Use

Given the flawed assumptions and undocumented sources of data associated with CARB staff's analysis of the emission impacts associated with biodiesel under the proposed ADF, Sierra Research undertook a detailed analysis of the same issue. The first step in this analysis was identifying the most current methods and tools for estimating NOx emissions from on- and non-road diesel engines operating in California for which biodiesel use is expected to increase NOx emissions.

ADF 17-30

On-Road Heavy-Duty Diesel Vehicles – On December 30, 2014, CARB officially released the final version of the EMFAC2014 model for estimating on-road emissions in California, which has replaced the now obsolete EMFAC2011 model that CARB staff relied upon for certain elements of its emission analysis. In releasing EMFAC2014, CARB staff noted a number of changes intended to improve the accuracy of the model relative to EMFAC2011. First, EMFAC2014 accounts for CARB's adoption of recent mobile source rules and regulations that lower future NOx emission estimates, including the Advanced Clean Cars program and the 2014 Amendments to the Truck and Bus Regulation. In addition, EMFAC2014 now estimates off-cycle emissions of SCR-equipped vehicles (i.e., NTDEs) by reflecting higher NOx emissions during low speed operation and cold starts.[8]

Given the above, Sierra selected EMFAC2014 for estimating NTDE emissions directly in this assessment. It was used to generate annual average NOx emissions, in tons per day, for the South Coast and San Joaquin Valley Air Basins, and the entire state for the years 2015, 2020, and 2023. Emission estimates were obtained for light-heavy-duty, medium-heavy-duty, and heavy-heavy-duty trucks, as well as school, urban, and transit buses. Output by "model year" was used to differentiate NOx emissions of legacy vehicles from those of NTDEs, which were defined as 2010 and later model-year vehicles consistent with the definition in proposed section 2293.2 Title 13, CCR (see Appendix A to the LCFS ISOR).

[8] Email from ARB EMFAC2014 Team, November 26, 2014.

Off-Road Diesel Equipment and Engines – The process of estimating emissions from off-road equipment and engines in California is much less straightforward than for on-road vehicles, as the most recent CARB models have been separated by equipment type and updated at various points in time as part of the rulemaking process associated with the development of regulations for different source categories.

In addition to having been developed and last updated at different points in time, some of the methodologies do not output data with sufficient detail (e.g., emissions by engine model year) to differentiate between "legacy vehicles" and NTDEs, which, in the case of off-road sources, are defined by CARB staff in proposed section 2293.2 Title 13 CCR as being compliant with Tier 4 final emission standards for non-road compression ignition (i.e., diesel) engines under sections 2421, 2423, 2424, 2425, 2425.1, 2426, and 2427 Title 13 CCR.[9] The effective dates of these standards vary as a function of engine power rating, as shown in Table 1. It should be noted that compliance with the Tier 4 Final standards by engines below 50 horsepower in general does not require the use of the SCR technology[10] that CARB has used to define "NTDEs." Therefore, all engines in this category were assumed to respond to biodiesel in the same way as legacy vehicles, despite the fact that they meet Tier 4 final standards and are technically classified as NTDEs by CARB under the ADF regulation. As discussed below, this again reduced the magnitude of the biodiesel NOx impact.

Table 1
Effective Dates of Tier 4 Final Standards

Horsepower Range	Model Year
50-75	2013
76-175	2015
176-750	2014
Over 751	2015

Table 2 summarizes current state of CARB inventory models and methodologies for off-road diesel emission sources by equipment/engine sector[11] and indicates which outputs have sufficient detail to differentiate between emissions from legacy vehicles and NTDEs. As shown, only the general off-road equipment (construction, industrial, ground support, and oil drilling equipment), cargo handling equipment, and agricultural equipment sectors could be included in the Sierra analyses for the South Coast and San Joaquin Valley Air Basins. For the statewide inventory, it was possible to include transportation refrigeration units (TRUs) as well. Given that all diesel emission categories could not be included in the Sierra analysis, it should be noted that the results of the analysis presented below are conservative in that they do not account for the full magnitude of the increase in NOx emissions related to biodiesel use in California.

[9] See ISOR Appendix A.
[10] See *http://www.arb.ca.gov/diesel/tru/tru.htm#mozTocId341892.*
[11] All models can be downloaded at *http://www.arb.ca.gov/msei/categories.htm* .

The CARB off-road emissions inventory tools were configured to include the impacts of the most recent regulatory actions in each sector, and were executed to provide estimates of annual average day NOx emissions for both legacy and NTDE vehicles for calendar years 2015, 2020, and 2023 occurring in the South Coast and San Joaquin Valley Air Basins, as well as the entire state.

Key Assumptions: The Sierra analysis of the emission impacts of biodiesel use in California relies on the following two key assumptions:

1. B5 will be in use on a statewide basis in 2015, 2020, and 2023;

2. At the B5 level, NOx emissions from legacy vehicles will be increased by 1%, and by 5% from NTDEs.

Table 2
Summary of Current California Off-Road Diesel Emission Inventory Methodologies

Category	CARB Model/Database Tool	Capable of Differentiating Legacy Vehicle and NDTE Emissions
In-Use Off-Road Equipment	2011 Inventory Model	Yes
Cargo Handling Equipment	2011 Inventory Model	Yes
Transportation Refrigeration Units	2011 TRU Emissions Inventory	Yes – but not capable of estimating emissions by air basin
Agricultural Equipment	OFFROAD2007	Yes
Stationary Engines	2010 StaComm Inventory Model	No
Locomotives	NA	No
Commercial Harborcraft	2011 CHC/CA Crew and Supply Vessel/CA Barge and Dredge Inventory Databases	No
Ocean-Going Vessels	2011 Marine Emissions Model	No

The assumption regarding B5 was based on the fact that it represents the highest blend allowed under the ADF without mitigation, at least during the summer months. That this assumption is reasonable can be seen by comparing CARB's current and previous assumptions of biodiesel use: in the current LCFS compliance scenario,[3] the staff assumes a range from about B3 in 2015 to about B4 in 2020; in 2009,[12] the staff assumed approximately B1 in 2015 and B5 in 2020; and

[12] CARB, Proposed Regulation to Implement the Low Carbon Fuel Standard, Volume II, Appendices, March 5, 2009.

in 2011,[13] approximately B10 in 2015 and B20 in 2020 were assumed. Furthermore, the Sierra results can be scaled to reflect lower or higher non-mitigated biodiesel levels by multiplying them by the ratio of the assumed biodiesel level to B5.

The assumptions of a 1% and 5% increase at B5 for legacy vehicles and NTDEs, respectively, are based on the analysis of Rincon Ranch Consulting,[7] where 5% represents the mid-point of the range of estimates.

Diesel Emission Inventory and Biodiesel Impacts

The results of the Sierra analysis for the statewide diesel inventory for 2015, 2020, and 2023 are presented in Table 3 along with the undocumented values published by CARB staff.[6] As shown, the Sierra values are lower than those used by CARB staff. This is expected to some degree given that the Sierra analysis does not include, as explained above, some diesel source categories; however, the difference cannot be reconciled given the lack of information made available by CARB staff regarding its analysis.

Table 3
Statewide Diesel Emissions tons/day

	2015	2020	2023
Sierra Analysis	621	436	277
CARB Table B-1, Appendix B ADF ISOR	863	634	496

Table 4 compares the results of Sierra's analysis with the results of the CARB staff's analysis. As shown, the differences are large and are due primarily to two factors: 1) the staff's assumption regarding biodiesel impacts on NTDE NOx emissions, which is contradicted by the available data; and 2) the differences in the assumed levels of biodiesel use. The impact of the latter difference can also be seen in the results presented in Table 4, where results from the Sierra analysis scaled to reflect the lower biodiesel use rates assumed by CARB staff are presented. Again, even with this adjustment, the results of the Sierra analysis indicate much greater NOx impacts under the proposed ADF. Finally, it should be recalled that because of limitations with CARB's emission inventory methods for off-road sources, not all sources of diesel emissions that could be impacted by biodiesel use under the ADF have been accounted for, and the actual impacts will be greater than those shown in Table 4.

ADF 17-31

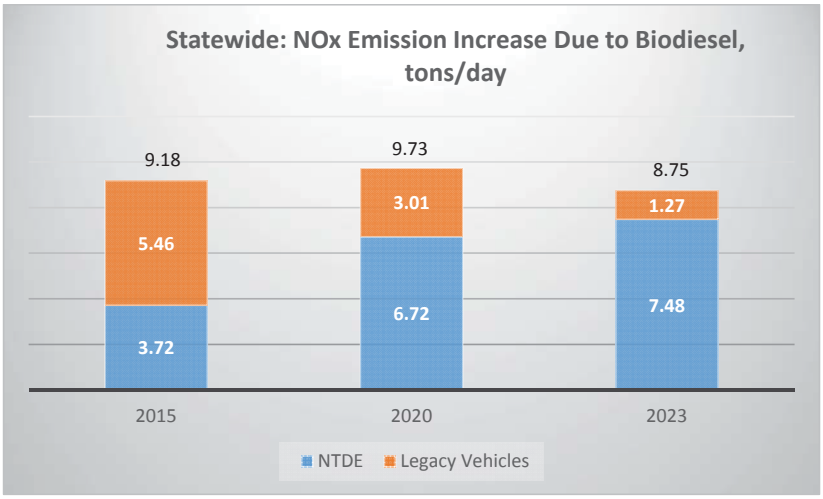
[13] CARB, Low Carbon Fuel Standard 2011 Program Review Report, December 8, 2011.

Table 4 Statewide Increase in NOx Emissions Due to Biodiesel tons/day			
	2015	2020	2023
Sierra Analysis – B5	9.18	9.73	8.75
Sierra Analysis at CARB Assumed Biodiesel Levels from Table B-1	4.70	7.15	6.15
CARB Table B-1, Appendix B ADF ISOR	1.29	0.39	0.01

ADF 17-31 cont.

The results of the Sierra analysis are shown graphically in Figures 1a through c for the entire state as well as the South Coast and San Joaquin air basins, respectively. These figures also show the relative contributions of legacy vehicles and NTDEs to the total estimated for each area and year. As shown, the contributions of NTDEs to increased NOx emissions are substantial in 2015, and dominate the impacts in 2020 and 2023. Further data supporting these results are provided in Tables 6 through 8 at the end of this attachment.

Figure 1a
Results of Sierra Analysis of Statewide NOx Increases
Due to Biodiesel Use under the Proposed ADF Regulation



ADF 17-32

Attachment D-9

Figure 1b
Results of Sierra Analysis of South Coast Air Basin NOx Increases Due to Biodiesel Use under the Proposed ADF Regulation

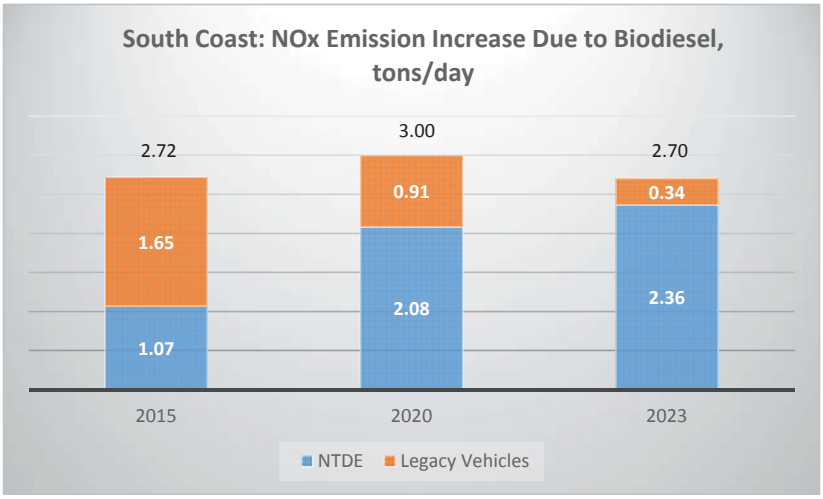
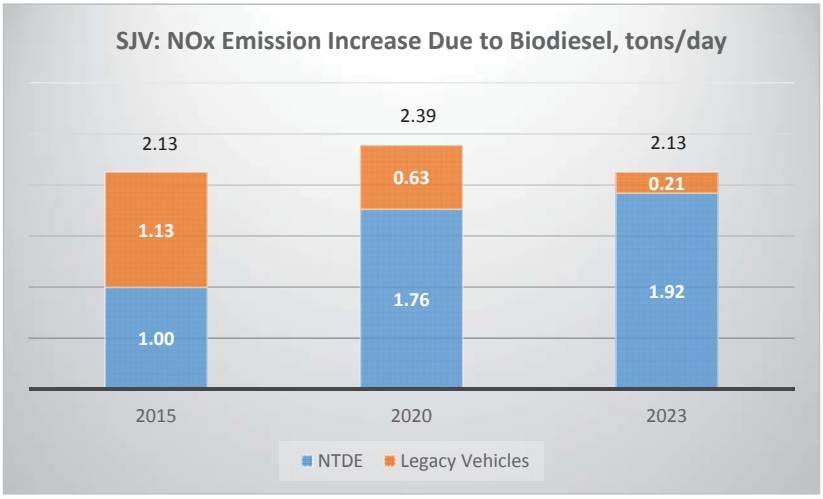


Figure 1c
Results of Sierra Analysis of San Joaquin Valley Air Basin NOx Increases Due to Biodiesel Use under the Proposed ADF Regulation



ADF 17-32
cont.

As indicated above, the Sierra analysis uses the results from an assessment of existing data regarding biodiesel impacts on NOx emissions from NTDEs performed by Rincon Ranch Consulting. The key findings of that analysis are shown in Figure 2 (reproduced with permission), which establishes that the available data for biodiesel impacts on NTDE NOx emissions follow a linear relationship just as they do for legacy vehicles.

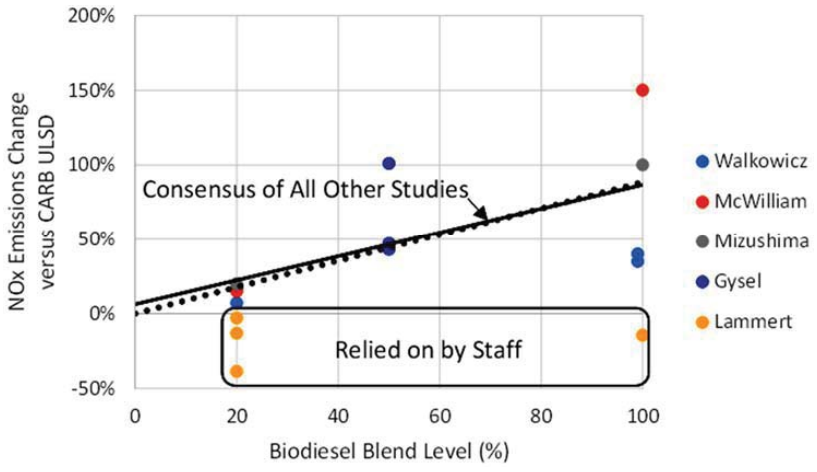
In contrast to the data upon which the Sierra analysis rests, the basis of CARB staff's assumption regarding biodiesel impacts on NTDE emissions rests on the following excerpts from the ADF ISOR:

> *Research also indicates that the use of biodiesel up to blends of B20 in NTDEs results in no detrimental NOx impacts. Therefore, the proposed regulation also includes a process for fleets and fueling stations to become exempted from the in-use requirements for biodiesel blends up to B20 as long as they can demonstrate to the satisfaction of the Executive Officer that they are fueling at least 90 percent light or medium duty vehicles or NTDEs.*
>
> *Staff proposes to take a precautionary approach and in the light of data showing there may be a NOx impact at higher biodiesel blends but not at lower biodiesel blends, staff is limiting the conclusion of no detrimental NOx impacts in NTDEs to blends of B20 and below.*

Clearly, if CARB staff were truly taking a "precautionary approach" to the issue of biodiesel impacts on NTDE NOx emissions, they would also rely on the results of the analysis summarized in Figure 2.

ADF 17-32 cont.

Figure 2
The Impact of Biodiesel on NTDE NOx Emissions



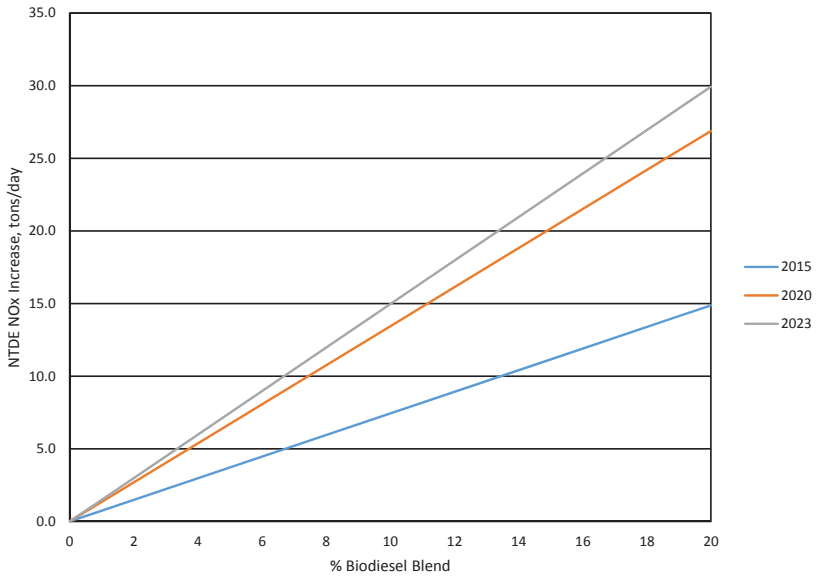
Attachment D-11

The assumption made by CARB staff regarding biodiesel impacts on NDTE NOx emissions has additional ramifications beyond those shown above by the results of the Sierra analysis. As set forth in proposed section 2293.6, Title 13 CCR (see ISOR Appendix A), the mitigation requirements for biodiesel up to the B20 level will be dropped when NTDEs account for 90% of heavy-duty vehicle miles travelled in California (expected by staff to be 2023) and use of B20 without mitigation will be allowed in all fleets of centrally fueled vehicles comprised of more than 90% NTDEs. Given this, use of unmitigated biodiesel blends of up to B20 in NTDEs may be common under the proposed ADF regulation. The potential significance of these provisions of the staff proposal with respect to the potential for NOx increases is shown in Figures 3a through 3c, which illustrate the estimated increases in NDTE NOx emissions as a function of biodiesel content up to B20 for the state, the South Coast air basin, and the San Joaquin Valley air basins, respectively, for the years 2015, 2020, and 2023.

As shown, the potential NOx increases from extensive use of higher level biodiesel blends in NTDEs is quite large. Furthermore, although the results shown in Figures 3a through 3c are maximum potential impacts, they can again be simply scaled for other cases. For example, in order to estimate statewide NOx increases from B20 use in 50% rather than 100% of NTDEs, one would simply multiply the value of 30 tons per day by 0.5 (50/100) to arrive at a 15 ton per day increase. Finally, it should be noted that the values in Figures 3a through 3c reflect both on- and off-road NTDEs as described above for the Sierra analysis of B5 impacts.

ADF 17-33

Figure 3a
Results of Sierra Analysis of Statewide NOx Increases Due to Biodiesel Use in All NTDEs under the Proposed ADF Regulation



Attachment D-12

Figure 3b
Results of Sierra Analysis of South Coast Air Basin NOx Increases Due to Biodiesel Use in All NTDEs under the Proposed ADF Regulation

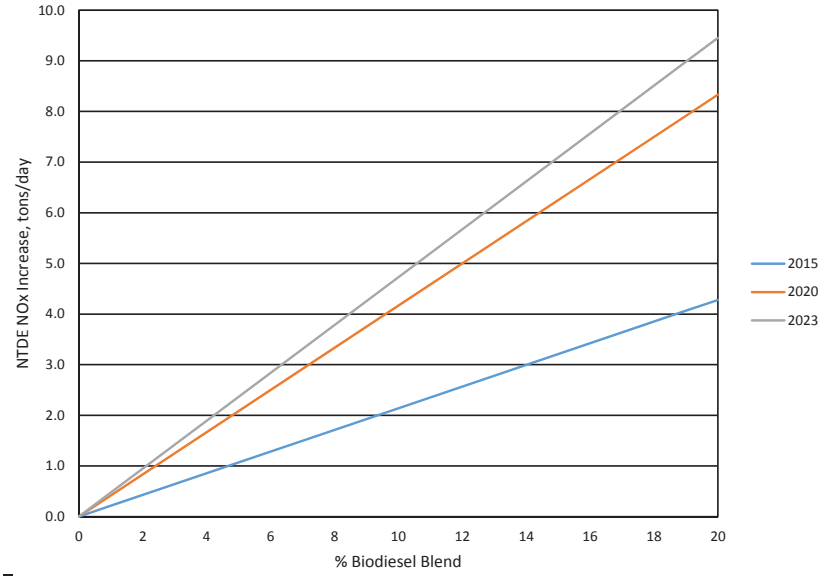
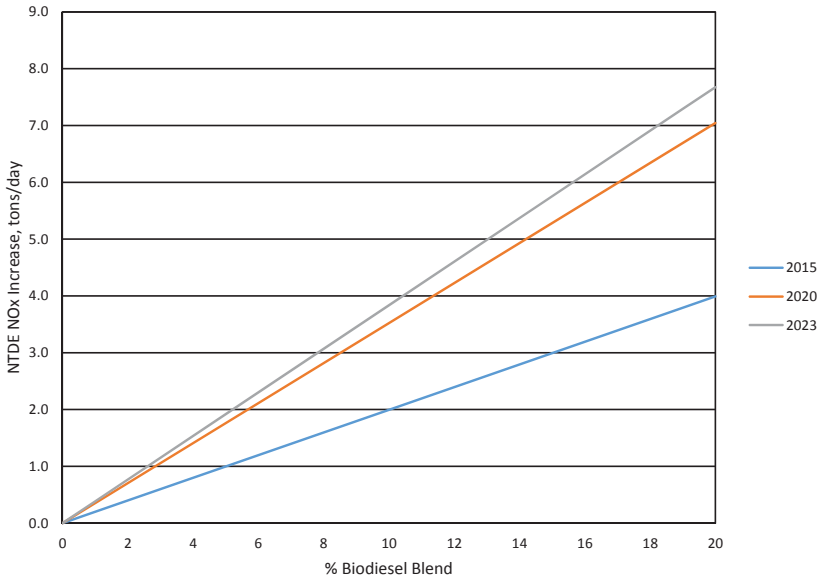


Figure 3C
Results of Sierra Analysis of San Joaquin Valley Air Basin NOx Increases Due to Biodiesel Use in All NTDEs Under the Proposed ADF Regulation



ADF 17-33
cont.

Attachment D-13

Significance of Increases in NOx Emissions Caused by Biodiesel

As illustrated above, the proposed ADF regulations are likely to lead to substantial increases in NOx emissions for the state as a whole, as well as in the South Coast and San Joaquin Valley air basins, which are in extreme nonattainment of the federal standard for ozone and experience the state's highest levels of ozone and other pollutants. The significance of the NOx increases from biodiesel can be seen by comparing those increases with air quality planning documents.

Perhaps the best initial point of reference comes from CARB's "Vision for Clean Air"[14] prepared in conjunction with the South Coast Air Quality Management District and the San Joaquin Valley Unified Air Pollution Control District. This report addresses potential control strategies that will be required to bring these extreme ozone nonattainment areas into compliance. According to the Vision report, NOx emissions will have to be reduced by 80% to 90% from 2010 levels in both the South Coast and San Joaquin Valley areas in order to achieve ozone compliance. Furthermore, in working to identify potential control strategies, the three regulatory agencies chose to focus **only** on ways to reduce NOx emissions (and not hydrocarbon emissions) because, in their words, *"NOx is the most critical pollutant for reducing regional ozone and fine particulate matter."* Given this, CARB staff's proposal to allow any NOx emission increases from the use of biodiesel is difficult to understand.

ADF 17-34

CARB staff's proposal becomes even more difficult to understand when the emission increases from biodiesel are compared to the emission benefits from adopted and proposed control measures. As an illustration, the NOx reductions expected from transportation control measures in the South Coast Basin that are part of the district's Air Quality Plan[15] are compared in Table 5 to estimated NOx emission increases under the ADF based on Sierra's analysis of B5. As shown, the increases due to biodiesel are far larger than the reductions from transportation control measures and completely offset the benefits of those measures that must be implemented as the result of their being included in the Air Quality Plan.

ADF 17-35

Table 5
Comparison of NOx Reductions from South Coast Transportation Control Measures (TCMs) and Estimated NOx Increases from Biodiesel Under the Proposed ADF Regulation

Calendar Year	NOx Reduction from TCMs, tons/day	NOx Increase due to Biodiesel tons/day
2014/2015	-0.7	2.72
2019/2020	-1.4	3.00
2023	-1.5	2.70

[14] California Air Resources Board, Vision for Clean Air: A Framework for Air Quality and Climate Planning, June 27, 2012.
[15] See South Coast 2012 AQMP. Appendix IV C. *http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2012-air-quality-management-plan/final-2012-aqmp-(february-2013)/appendix-iv-(c)-final-2012.pdf*

Similarly, the approximately two ton per day NOx increase estimated from the use of biodiesel in the San Joaquin Valley under the ADF can be compared to planned and implemented NOx control measures,[16,17] many of which have emission benefits on the order of two tons per day or less. Again, it should also be noted that the potential NOx emission increases allowed under the proposed ADF from extensive use of B20 in NDTEs without mitigation are far greater than the fleetwide impacts associated with the use of B5.

ADF 17-35 cont.

[16] San Joaquin Valley Air Pollution Control District, 2007 Ozone Plan and Appendices and Updates.
[17] San Joaquin Valley Air Pollution Control District, 2010 Ozone Mid-Course Review, June 2010.

Table 6
Results of Sierra Research Statewide Analysis

Statewide Total NOx Emissions Inventory, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	493.3	345.0	204.9
Construction/Mining/Drilling	75.8	56.6	43.6
Cargo Handling Equipment (CHE)	4.02	3.13	2.70
Transportation Refrigiration Units (TRU)	13.33	11.25	12.26
Agricultural Equipment	34.35	19.75	13.44
TOTAL	620.8	435.7	276.9
Statewide NTDE NOx Emissions Inventory, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	73.0	127.2	138.2
Construction/Mining/Drilling	0.8	5.5	9.0
Cargo Handling Equipment (CHE)	0.26	0.89	1.22
Transportation Refrigiration Units (TRU)	0.00	0.00	0.00
Agricultural Equipment	0.21	0.85	1.23
TOTAL	74.4	134.4	149.6
Statewide NOx Emissions Increase Due to B5 , tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	7.8550	8.5374	7.5764
Construction/Mining/Drilling	0.7916	0.7850	0.7962
Cargo Handling Equipment (CHE)	0.0506	0.0668	0.0757
Transportation Refrigiration Units (TRU)	0.1333	0.1125	0.1226
Agricultural Equipment	0.3520	0.2317	0.1837
TOTAL	9.18	9.73	8.75
Statewide NTDE NOx Emission Increase Due to B5, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	3.6523	6.3596	6.9092
Construction/Mining/Drilling	0.0424	0.2735	0.4507
Cargo Handling Equipment (CHE)	0.0131	0.0444	0.0609
Transportation Refrigiration Units (TRU)	0.0000	0.0000	0.0000
Agricultural Equipment	0.0106	0.0427	0.0617
TOTAL	3.72	6.72	7.48
Statewide Legacy Vehicle NOx Emission Increase Due to B5, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	4.2027	2.1778	0.6672
Construction/Mining/Drilling	0.7492	0.5115	0.3454
Cargo Handling Equipment (CHE)	0.0375	0.0224	0.0148
Transportation Refrigiration Units (TRU)	0.1333	0.1125	0.1226
Agricultural Equipment	0.3414	0.1890	0.1220
TOTAL	5.46	3.01	1.27

Attachment D-16

Table 7
Results of Sierra Research South Coast Air Basin Analysis

South Coast Total NOx Emissions Inventory, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	153.0	107.9	62.3
Construction/Mining/Drilling	28.0	21.5	15.9
Cargo Handling Equipment (CHE)	3.21	2.53	2.20
Agricultural Equipment	2.18	1.23	0.84
TOTAL	186.4	133.1	81.3
South Coast NTDE NOx Emissions Inventory, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	20.8	38.7	42.8
Construction/Mining/Drilling	0.3	2.1	3.3
Cargo Handling Equipment (CHE)	0.24	0.79	1.08
Agricultural Equipment	0.01	0.05	0.07
TOTAL	21.4	41.7	47.3
South Coast NOx Emission Increase Due to B5 , tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	2.3624	2.6270	2.3340
Construction/Mining/Drilling	0.2931	0.2993	0.2929
Cargo Handling Equipment (CHE)	0.0416	0.0568	0.0652
Agricultural Equipment	0.0223	0.0144	0.0113
TOTAL	2.72	3.00	2.70
South Coast NTDE NOx Emission Increase Due to B5, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	1.0410	1.9352	2.1385
Construction/Mining/Drilling	0.0161	0.1056	0.1673
Cargo Handling Equipment (CHE)	0.0118	0.0393	0.0539
Agricultural Equipment	0.0006	0.0026	0.0037
TOTAL	1.07	2.08	2.36
South Coast Legacy Vehicle NOx Emission Increase Due to B5, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	1.3213	0.6918	0.1955
Construction/Mining/Drilling	0.2770	0.1938	0.1256
Cargo Handling Equipment (CHE)	0.0298	0.0175	0.0112
Agricultural Equipment	0.0216	0.0118	0.0076
TOTAL	1.65	0.91	0.34

Table 8
Results of Sierra Research San Joaquin Valley Analysis

San Joaquin Valley Total NOx Emissions Inventory, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	103.9	77.1	43.9
Construction/Mining/Drilling	14.0	12.1	9.4
Cargo Handling Equipment (CHE)	0.09	0.06	0.06
Agricultural Equipment	14.81	8.58	5.82
TOTAL	132.8	97.8	59.2
San Joaquin Valley NTDE NOx Emissions Inventory, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	19.7	33.7	35.9
Construction/Mining/Drilling	0.1	1.1	1.9
Cargo Handling Equipment (CHE)	0.00	0.01	0.01
Agricultural Equipment	0.09	0.36	0.53
TOTAL	20.0	35.2	38.4
San Joaquin Valley NOx Emission Increase Due to B5 , tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	1.8277	2.1196	1.8769
Construction/Mining/Drilling	0.1459	0.1661	0.1696
Cargo Handling Equipment (CHE)	0.0010	0.0011	0.0011
Agricultural Equipment	0.1517	0.1003	0.0793
TOTAL	2.13	2.39	2.13
San Joaquin Valley NTDE NOx Emission Increase Due to B5, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	0.9857	1.6862	1.7973
Construction/Mining/Drilling	0.0075	0.0560	0.0941
Cargo Handling Equipment (CHE)	0.0001	0.0005	0.0007
Agricultural Equipment	0.0046	0.0182	0.0264
TOTAL	1.00	1.76	1.92
San Joaquin Valley Legacy Vehicle NOx Emission Increase Due to B5, tons/day			
	2015	2020	2023
Trucks (LHD1, LHD2, MHD, HHD, Buses)	0.8421	0.4333	0.0796
Construction/Mining/Drilling	0.1384	0.1101	0.0755
Cargo Handling Equipment (CHE)	0.0009	0.0005	0.0004
Agricultural Equipment	0.1471	0.0822	0.0529
TOTAL	1.13	0.63	0.21

17_OP_ADF_GE Responses (Page 253 – 270)

119. Comment: **ADF 17-24 through ADF 17-35**

Agency Response:
The responses to these comments are in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

Attachment E

Assessment of CARB's Environmental Analysis and ADF Mitigation Requirements

In developing the proposed Alternative Diesel Fuel (ADF) regulation, CARB staff has performed an environmental analysis and included mitigation requirements intended to eliminate the adverse environmental impacts associated with increased NOx emissions resulting from the use of biodiesel under the ADF. ADF 17-36

The environmental analysis is fundamentally flawed in that staff incorrectly selected 2014 as the baseline year and performed the analysis in light of biodiesel usage levels in that year. As documented below, CARB staff has long been aware that biodiesel use leads to increases in NOx emissions, and promised but failed to act to address those emissions through enactment of an ADF regulation as early as 2009. There is no basis for an agency to use its failure to promptly act to address an environmental issue of which it was clearly aware as grounds to change the baseline for assessing its' proposed effort to address that issue. This is even more apparent given that CARB staff acknowledges that a key function of the LCFS regulation is to incent low carbon intensity fuels including biodiesel which has to date generated 13% of all credits issued by CARB under the LCFS.[1] Given this, the proper baseline for assessing the ADF regulation should be 2009 when CARB first stated it would regulate biodiesel use and when, by CARB staff's own admission, little biodiesel was used in California and NOx emissions were minimal. ADF 17-37

The mitigation requirements of the ADF regulation are equally flawed. First, they are based on CARB's staff's fundamentally flawed emission analysis, and second their implementation is unreasonably delayed until 2018—more than ten years after CARB staff was aware that biodiesel use in California would lead to increased NOx emissions. ADF 17-38

History of the ADF Regulation

Although the U.S. Environmental Protection Agency (EPA) published a report in 2002 showing that biodiesel use increases NOx emissions linearly with increasing biodiesel content,[2] the earliest document found on the CARB website indicates that agency discussions regarding the need to adopt regulations addressing NOx began at least as early as February 2004.[3] This led to the first meeting of the Biodiesel Work Group in April 2004.[4] A summary of that discussion

[1] See Page III-2 of the LCFS ISOR.
[2] See EPA, A Comprehensive Analysis of Biodiesel Impacts on Exhaust Emissions (available at http://www.epa.gov/otaq/models/analysis/biodsl/p02001.pdf).
[3] See CARB, Public Consultation Meeting Regulatory and Non-Regulatory Fuels Activities at 26-29 (Feb. 25, 2004) (available at http://www.arb.ca.gov/fuels/diesel/022504arb.pdf).
[4] See CARB Ltr. (Mar. 18, 2004) (available at http://www.arb.ca.gov/fuels/diesel/altdiesel/041204altdslwsh.pdf).

published at the time[5] it occurred indicates that topics discussed included ways to mitigate NOx emission increases associated with biodiesel use.

In 2006, CARB published a draft guidance document regarding the use of biodiesel in California,[6] at which time the agency simply decided not to address increased NOx emissions until biodiesel use became more widespread.[7] At that time, CARB instead could have ensured that there would be no NOx increases from biodiesel use by simply requiring those interested in selling biodiesel in California to demonstrate that they could formulate biodiesel blends in a way that did not increase NOx emissions, which is one of the approaches CARB is now considering.[8]

The first time CARB was scheduled to adopt regulations addressing this issue was in November 2009; this is indicated on page 12 of CARB's 2009 Rulemaking Calendar,[9] which includes the following summary:

> *Staff will propose motor vehicle fuel specifications for biodiesel and renewable diesel. These specifications are necessary for the implementation of the Low Carbon Fuel Standard regulation (to be considered at the March 2009 Hearing).*

ADF 17-39

No action was taken by CARB in 2009 and the planned adoption date was moved to June 2010; this is evidenced by CARB's 2010 Rulemaking Calendar,[10] which lists the regulatory item on page 11. This time the summary reads:

> *The staff will propose adoption of new motor vehicle fuel specifications for biodiesel and renewable diesel. These specifications are necessary to ensure that the use of these fuels will not increase emissions of criteria and toxic air pollutants when used as a motor vehicle fuel.*

Again, no action was taken by CARB in 2010 and the planned adoption date was moved to November 2011; this is evidenced by CARB's 2011 Rulemaking Calendar,[11] which lists the regulatory item on page 14. This time the summary reads:

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[5] See *CVS News*, at 27-31 (May 2004) (available at http://www.sierraresearch.com/documents/cvs_news_may_2004.pdf).
[6] See CARB, Draft Advisory on Biodiesel Use (Nov. 14, 2006) (available at http://www.arb.ca.gov/fuels/diesel/altdiesel/111606biodsl_advisory.pdf).
[7] See CARB, Suggested ARB Biodiesel Policy (May 24, 2006) (available at http://www.arb.ca.gov/fuels/diesel/altdiesel/052406arb_prsntn.pdf).
[8] See California Environmental Protection Agency, Discussion of Conceptual Approach to Regulation of Alternative Diesel Fuels (Feb. 15, 2013).
[9] See CARB, 2009 Rulemaking Calendar Schedule (available at http://www.arb.ca.gov/regact/2009rulemakingcalendar.pdf).
[10] See CARB, 2010 Rulemaking Calendar Schedule (available at http://www.arb.ca.gov/regact/2010rulemakingcalendar.pdf).
[11] See CARB, 2011 Rulemaking Calendar Schedule (available at http://www.arb.ca.gov/regact/2011rulemakingcalendar.pdf).

The Low Carbon Fuel Standard incents the use of biodiesel and renewable diesel, for which there are no current emissions–based fuel specifications. Staff will propose fuel specifications for both of these diesel blendstocks.

Yet again, no action was taken by CARB in 2011 and the planned adoption date was moved to November 2012; this is evidenced by CARB's 2012 Rulemaking Calendar,[12] which lists the regulatory item on page 14. This time the summary reads:

Rulemaking to establish commercial fuel specifications for blends of commercial diesel fuel and neat biodiesel in amounts greater than five volume percent.

Yet again, no action was taken by CARB in 2012 and, for the fourth consecutive year, the item was scheduled to be presented to the Board—the CARB Rulemaking Calendar for 2013[13] indicates on page 8 that the Board is currently scheduled to consider adoption of amendments to the agency's Alternative Diesel Fuel Regulations in September 2013. This time the summary reads:

ADF 17-39 cont.

Proposed new motor vehicle alternative diesel fuel specifications and commensurate amendments to the diesel fuel regulations.

Unlike the previous years, during 2013 CARB staff did begin to take action to actually develop a regulation that it purported would address increases in NOx emissions resulting from biodiesel use. The hearing notice[14] and Initial Statement of Reasons[15] for the proposed ADF regulation were published in October 2013, in advance of a Board hearing to be held on December 12-13, 2013. However, that hearing was postponed to until March 20, 2014,[16] and then the entire rulemaking was abandoned prior to the March 2014 hearing.[17]

History of Biodiesel Use

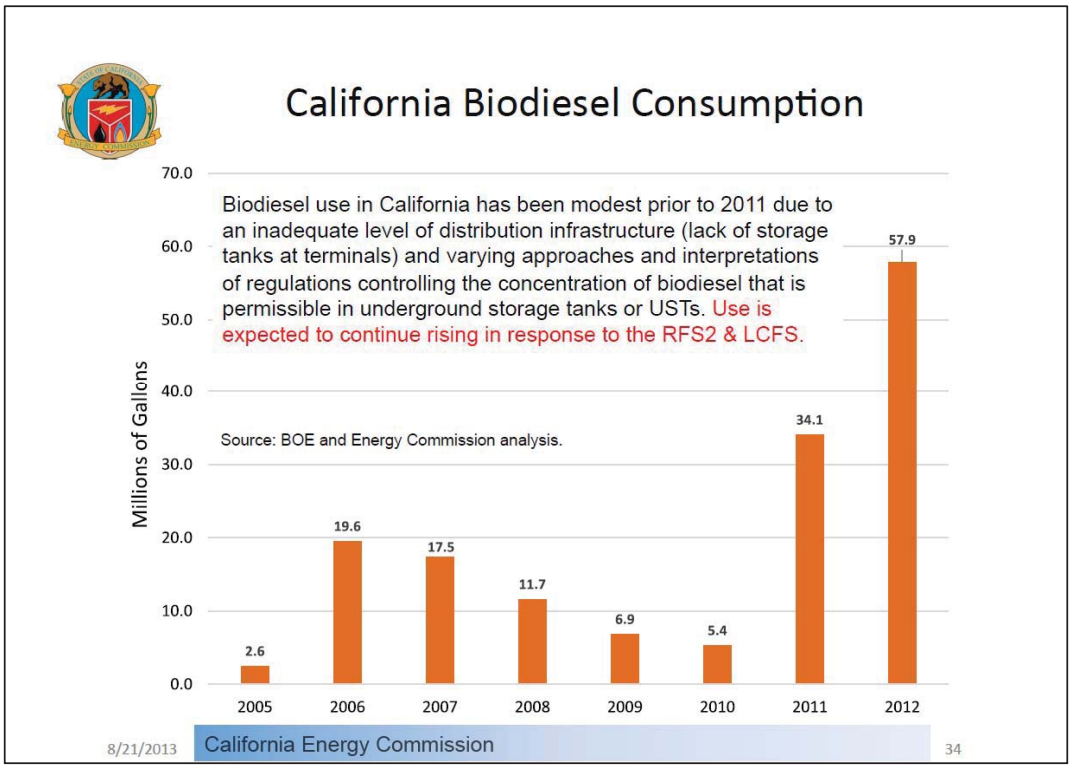
Although CARB does not disclose the amounts of biodiesel used in California prior to 72 million gallons estimated in 2014 in the ADF rulemaking documents (see ISOR Appendix B), data for 2005 to 2012 are available from the California Energy Commission.[18] These data are shown in Figure 1 below. As shown, biodiesel use in California increased dramatically in 2006 when CARB staff indicated that it would not regulate biodiesel, and then decreased until the LCFS

[12] See CARB, 20012 Rulemaking Calendar Schedule (available at http://www.arb.ca.gov/regact/2012rulemakingcalendar.pdf).
[13] See CARB, 2013 Rulemaking Calendar Schedule (available at http://www.arb.ca.gov/regact/2013rmcal.pdf).
[14] See http://www.arb.ca.gov/regact/2013/adf2013/adf2013notice.pdf
[15] See http://www.arb.ca.gov/regact/2013/adf2013/adf2013isor.pdf
[16] See http://www.arb.ca.gov/regact/2013/adf2013/adf2013postpone.pdf
[17] See http://www.arb.ca.gov/regact/2013/adf2013/NDNPadf2013.pdf
[18] See http://www.energy.ca.gov/2013_energypolicy/documents/2013-08-21_workshop/presentations/06_Schremp_Biofuels.pdf

took effect in 2011 at which point it again increased dramatically. Clearly, the appropriate baseline year for analysis of the ADF regulation is 2009 or 2010 when CARB first committed to adopting a regulation to address biodiesel NOx impacts, not any later year after which substantial increases in biodiesel use occurred in response to the LCFS.

ADF 17-40

Figure 1
Biodiesel Consumption in California as Reported by the California Energy Commission



The NOx increases resulting from CARB's failure to regulate biodiesel during the period from 2005 to 2014 are summarized in Table 1. The values presented are approximate and are based on the Sierra Research methodology for 2015 adjusted to account for differences in biodiesel use as well as the absence of NTDE engines in years prior to 2010. Biodiesel use for 2014 is taken from Appendix B of the ADF ISOR, and the estimated use for 2013 assumed linear growth in biodiesel use from 2012 to 2014. Significant increases in NOx emissions from 2011 to 2014 can be seen from a comparison of the values presented in Table 1 with the values presented in Table B-1 of Appendix B to the ADF ISOR. These increased NOx emissions from 2011 to 2014 total 782, 1032, and 3,463 tons for the San Joaquin Valley, South Coast, and entire state, respectively.

ADF 17-41

Table 1 Estimated Increases in NOx Emissions Due to Biodiesel Use in California from 2005 to 2014 (tons per year)			
Calendar Year	Statewide	South Coast	San Joaquin Valley
2005	31	9	7
2006	234	70	50
2007	209	63	45
2008	140	42	30
2009	82	25	18
2010	65	19	14
2011	447	134	98
2012	825	246	184
2013	1000	298	227
2014	1191	354	273
Total	4225	1260	945

ADF 17-41 cont.

Proposed ADF Mitigation Requirements

Under the proposed ADF regulation,[19] mitigation is generally required for "low-saturation" biodiesel blends with diesel fuel above B5 (e.g., B6 and higher) during the summer, and above B10 (e.g., B11 and higher) during the winter, unless the fuels are used in vehicles with new technology diesel engines in which case mitigation is not required for levels up to B20. For "high-saturation" biodiesel blends with diesel fuel, mitigation is required year-round above B10 (e.g., B11 and higher) again, unless the fuels are used in vehicles with new technology diesel engines in which case mitigation is not required for levels up to B20. However, no mitigation is required for any biodiesel blend sold in California prior to January 1, 2018.

ADF 17-42

According to the ADF ISOR,[20] CARB staff selected these levels based on an "analysis" for which no detail or documentation has been provided, and that reportedly included consideration of the impacts of new technology diesel engines (NTDEs) and the use of renewable diesel as "offsetting factors." Although it is impossible to thoroughly review an analysis which is not described in detail, in this case it can still be demonstrated to be fundamentally flawed. As discussed elsewhere, CARB incorrectly assumes that NOx emissions from NTDEs are unaffected by biodiesel despite the fact that available data show statistically significant increases in NOx emissions. Further, CARB cannot rely on the use of renewable diesel as mitigation for NOx increases from biodiesel as there is nothing in the ADF or the LCFS regulation that mandates the use of any volume of renewable diesel in California, nor which links the amount of renewable diesel used to the amount of biodiesel used. Further, neither the ADF nor LCFS regulations ensure that fuel producers will use biodiesel in a manner that provides surplus

ADF 17-43

[19] Proposed section 2293.6 Title 13, CCR in ISOR Appendix A.
[20] Chapter 6, Part H.

reductions[21] in NOx emissions. Given that CARB's reliance on "offsetting factors" is fundamentally flawed, the agency's "Determination of NOx Control Level for Biodiesel" is also fundamentally flawed. Another problem with the "determination" is that CARB staff claims to have performed an "analysis" for which no detail or documentation is provided, indicating that the higher blend level threshold for mitigation that applies to "low-saturation" blends during the winter months will not result in adverse air quality impacts. Again, it is not possible to critically review an analysis which is not described in detail; further, the information provided in this analysis is so insufficient that it is not even possible to develop an appropriate set of comments.

ADF 17-43 cont.

In addition to the flaws in CARB staff's analysis of what mitigation should be applied to address the increased NOx emissions associated with biodiesel use, CARB staff is arbitrarily delaying the date on which mitigation is required by two years from the expected effective date of the ADF regulation. According to ADF ISOR, CARB staff claim the reason for this delay is:

> *ARB is also proposing the in-use requirements come into effect on January 1, 2018, as time is needed to overcome logistical and other issues in implementation of in-use requirements. For example, use of the additive Di-tert-butyl peroxide (DTBP) will require replacement of steel tanks with stainless steel tanks, permitting of hazardous substance storage, approval by local fire agencies, additional additization infrastructure, and logistical business changes to acquire the additive. All of this is expected to take around 2 years to complete. Another method of compliance is re-routing higher blends to NTDEs. Research shows that the use of biodiesel in blends up to B20 in NTDEs results in no detrimental NOx impacts. This and other methods of complying with the in-use requirements, such as certification of additional options are also expected to take 2 years or more. Because compliance with the in-use options would be infeasible during initial implementation on January 1, 2016, only recordkeeping and reporting provisions will be implemented initially. The in-use requirements are proposed to come into effect on January 1, 2018.*

ADF 17-44

It is not clear why CARB staff believes that a two year delay in the implementation of mitigation requirements is required under the ADF regulation when the maximum delay in the implementation of new requirements under the LCFS regulation, which will much more dramatically impact fuel producers than the ADF requirements, is only one year, until January 1, 2017. Further, as the biodiesel industry has been on notice that CARB intended to impose NOx mitigation requirements for over ten years, it is not clear why such measures cannot be required from the expected January 1, 2016 effective date of the proposed regulation.

The impact of the failure to immediately require Biodiesel mitigation under the ADF regulation is shown in Table 2. These values are based on the Sierra Research emissions methodology which assumes statewide use of B5. As discussed elsewhere, these impacts

[21] In order to generate surplus reductions in NOx, renewable diesel would have to be blended into diesel fuel downstream of refineries, and although CARB staff has assumed that this will occur they have provided no basis for that assumption.

are significant in that the increases are as large or larger than those sought from emission control measures implemented of under consideration by CARB and local air pollution control agencies in the South Coast and San Joaquin Valley air basins.

Table 2
Potential NOx Increases Due to CARB's Failure to Require Immediate Biodiesel Mitigation Under the ADF
(tons per year)

	Statewide	South Coast	San Joaquin Valley
2016	3405	1013	796
2017	3460	1034	815
Total	6866	2047	1612

ADF 17-44 cont.

17_OP_ADF_GE Responses (Page 271 – 277)

120. Comment: **ADF 17-36 through ADF 17-44**

Agency Response:
The responses to these comments are in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

Attachment F

Potential for Actual Biodiesel Blend Levels to Exceed Levels Purported Under the Proposed ADF Regulation

In order to properly understand and mitigate the adverse environmental impacts of biodiesel blends sold in California, it is critical that the actual amount of biodiesel present in a blend be accurately known. Despite this, the proposed ADF regulation fails to adequately ensure that the actual biodiesel content of biodiesel blends—and therefore their adverse environmental impacts—will be accurately known or appropriately mitigated. As discussed below, significant changes are required to definitions used in the proposed LCFS and ADF regulations, and new testing, recordkeeping, and reporting requirements need to be added to the ADF regulation to prevent the blending of biodiesel with fuels that already contain undisclosed amounts of biodiesel.

ADF 17-45

Background

CARB regulations at §2281 and §2282, Title 13, California Code of Regulations apply to vehicular diesel fuel sold in California and define "diesel fuel" as follows:

> *"Diesel fuel" means any fuel that is commonly or commercially known, sold or represented as diesel fuel, including any mixture of primarily liquid hydrocarbons – organic compounds consisting exclusively of the elements carbon and hydrogen – that is sold or represented as suitable for use in an internal combustion, compression-ignition engine."*[1]

The proposed LCFS regulation contains the following definitions that are relevant to biodiesel blends (See ISOR Appendix A):[2]

> *"B100" means biodiesel meeting ASTM D6751-14 (2014) (Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels), which is incorporated herein by reference.*
>
> *"Biodiesel" means a diesel fuel substitute produced from nonpetroleum renewable resources that meet the registration requirements for fuels and fuel additives established by the Environmental Protection Agency under section 211 of the Clean Air Act. It includes biodiesel meeting all the following:*

[1] 13 CCR §2281(b)(1) and §2282(b)(3)
[2] See proposed §95481, Title 17, California Code of Regulations

(A) Registered as a motor vehicle fuel or fuel additive under 40 Code of Federal Regulations (CFR) part 79;
(B) A mono-alkyl ester;
(C) Meets ASTM D6751-08 (2014), Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels, which is incorporated herein by reference;
(D) Intended for use in engines that are designed to run on conventional diesel fuel; and
(E) Derived from nonpetroleum renewable resources.

"Biodiesel Blend" means a blend of biodiesel and diesel fuel containing 6 percent (B6) to 20 percent (B20) biodiesel and meeting ASTM D7467-13 (2013), Specification for Diesel Fuel Oil, Biodiesel Blend (B6 to B20), which is incorporated herein by reference.

"Diesel Fuel" (also called conventional diesel fuel) has the same meaning as specified in California Code of Regulations, title 13, section 2281(b).

"Diesel Fuel Blend" means a blend of diesel fuel and biodiesel containing no more than 5 percent (B5) biodiesel by weight and meeting ASTM D975-14a, (2014), Standard Specification for Diesel Fuel Oils, which is incorporated herein by reference.

Finally, the proposed ADF regulation contains the following definitions that are relevant to biodiesel blends:[3]

"Alternative diesel fuel" or "ADF" means any fuel used in a compression ignition engine that is not petroleum-based, does not consist solely of hydrocarbons, and is not subject to a specification under subarticle 1 of this article.

"Biodiesel" means a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats that is 99-100 percent biodiesel by volume (B100 or B99) and meets the specifications set forth by ASTM International in the latest version of Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels D6751 contained in the ASTM publication entitled: Annual Book of ASTM Standards, Section 5, as defined in California Code of Regulations, title 4, section 4140(a), which is hereby incorporated by reference.

"Biodiesel Blend" means biodiesel blended with petroleum-based CARB diesel fuel or non-ester renewable diesel.

[3] See proposed §2293.2(a), Title 13, California Code of Regulations

"Blend Level" means the ratio of an ADF to the CARB diesel it is blended with, expressed as a percent by volume. The blend level may also be expressed as "AXX," where "A" represents the particular ADF and "XX" represents the percent by volume that ADF is present in the blend with CARB diesel (e.g., a 20 percent by volume biodiesel/CARB diesel blend is denoted as "B20").

"B5" means a biodiesel blend containing no more than five percent biodiesel by volume.

"B20" means a biodiesel blend containing more than five and no more than 20 percent biodiesel by volume.

"CARB diesel" means a light or middle distillate fuel that may be comingled with up to five (5) volume percent biodiesel and meets the definition and requirements for "diesel fuel" or "California nonvehicular diesel fuel" as specified in California Code of Regulations, title 13, section 2281 et seq. "CARB diesel" may include: non-ester renewable diesel; gas-to-liquid fuels; Fischer-Tropsch diesel; diesel fuel produced from renewable crude; CARB diesel blended with additives specifically formulated to reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel; and CARB diesel specifically formulated to reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel.

Discussion

The first issue related to the potential for uncertainty and inaccuracy in actual biodiesel content of fuels sold in California involves the different definitions that have been proposed for the term "biodiesel" under the proposed LCFS and ADF regulations. Although the two definitions may be functionally equivalent, they should be made the same under both the LCFS and ADF regulations unless CARB staff can articulate a compelling need for the use of different definitions to describe the same thing.

More importantly, the term "Biodiesel Blend" in the proposed LCFS regulation directly conflicts with the use of the same exact term in the proposed ADF regulation: a "Biodiesel Blend" under the LCFS regulations contains at least 6% biodiesel, while a "Biodiesel Blend" under the ADF is a diesel fuel containing any biodiesel. Furthermore, the LCFS regulation defines "Diesel Fuel Blend" as a blend of diesel fuel and up to 5% biodiesel, while such a fuel would be considered "CARB diesel" under the ADF regulation. Again, this haphazard use of the same term to describe fundamentally different fuels and different terms to describe the same fuel will assuredly lead to confusion in practice regarding the actual content of biodiesel available in California.

Further confusion is created by the definitions of "Biodiesel Blend" and "Blend Level" under the proposed ADF regulation. "Biodiesel Blend" is defined as a mixture of biodiesel and an undefined fuel referred to as "petroleum-based CARB diesel." "Blend

Level" applies to blends of all fuels subject to the ADF regulation, including biodiesel, and is defined as the ratio of an "Alternative diesel fuel" mixed with "CARB diesel." However, as noted above, "CARB diesel" may already contain as much as 5% biodiesel under the proposed ADF regulation. Furthermore, the definition of "Blend Level" includes no reference to the fuel termed "petroleum-based CARB diesel" that appears in the definition of "Biodiesel Blend" under the ADF—instead, it refers to "CARB diesel," which, as noted above, may contain as much as 5% biodiesel. Obviously, the addition of biodiesel to a fuel already containing some amount of biodiesel up to 5% will cause the actual biodiesel content to be higher than the blender expects; this, in turn, will lead to more significant adverse environmental impacts than expected. It is also clear that CARB staff mean for the definition of "Blend Level" to apply to "Biodiesel Blends," as that definition uses an example based on biodiesel (B20) to demonstrate the practical meaning of "Blend Level."

Finally, under the proposed ADF regulation, "B20" is nonsensically defined as a fuel that contains between 6% and 20% biodiesel, which directly contradicts the definition of "Blend Level" in same regulation. There appears to be no need for this definition or the definition of B5 in the proposed ADF regulation.

As outlined above, the proposed CARB LCFS and ADF regulations fail completely in clearly defining the four fuels that are of fundamental importance to ensuring that the biodiesel content of a fuels sold in California—and hence the adverse environmental impacts associated with their use—is accurately known. Instead, the proposed regulations make it likely that biodiesel blenders will unknowingly use fuels that already contain an unknown amount of biodiesel (up to 5%) in blending and that the actual biodiesel content of biodiesel blends may be as much as 5% greater than that represented by the blender and reported to CARB under the ADF regulation. This is significant because, as discussed in other attachments to this declaration, the increases in NOx emissions and associated adverse environmental impacts caused by biodiesel blends become larger in direct proportion to the amount of biodiesel present.

Both the LCFS and the ADF regulation must clearly define the four fuels described below.

1. ***"Diesel fuel"*** – This should defined as under 13 CCR §2281(b)(1) and §2282(b)(3).

2. ***"Biodiesel"*** or "***B100"*** – It appears that this could be properly defined through changes to the definitions currently proposed in the LCFS and ADF regulations; this is what should be blended only with "diesel fuel" to create a "Biodiesel Blend."

3. ***"CARB diesel"*** – This is accurately defined under the proposed ADF regulation, but under no circumstances should it be allowed to be blended with biodiesel or any other ADF. It should be renamed to clearly differentiate it from "diesel fuel" such that no reasonable person would understand that it could be legally mixed with any ADF.

ADF 17-45 cont.

4. ***"Biodiesel Blend"*** – This should refer to the "Blend Level" and must correspond to the actual amount of "Biodiesel" or "B100" in terms of percentage by volume in the final blend with "diesel fuel."

ADF 17-45 cont.

In addition to modifying the definitions as described above, the ADF regulation must also be modified to ensure that biodiesel blenders do not intentionally or unintentionally blend biodiesel into fuels that already contain biodiesel. This can easily be achieved by adding requirements to proposed §2293.8 Title 13, CCR, to require that any "diesel fuel" to be used in blending with biodiesel be tested for the presence of biodiesel prior to blending. Similarly, that section should be modified to include reporting and record keeping requirements for biodiesel blenders that document that they have used only biodiesel-free "diesel fuel" in all of their blending operations.

ADF 17-46

17_OP_ADF_GE Responses (Page 278 – 282)

121. Comment: **ADF 17-45 through ADF 17-46**

Agency Response:
The responses to these comments are in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

Attachment G

The Growth Energy Alternative to Proposed ADF Regulation is the Least-Burdensome Approach that Best Achieves the Project Objectives at the Least Cost That Must be Adopted

As part of the rulemaking process leading to CARB staff's proposed ADF regulation, staff was required to solicit and consider alternatives to the proposed regulation. Growth Energy submitted such an alternative which CARB staff acknowledged provided equivalent or superior reductions in NOx emissions from biodiesel use but rejected as being more costly. However, as is documented in detail below, CARB staff made fundamental errors in its' assessment of the Growth Energy Alternative, which will in fact provide greater reductions in NOx emissions from biodiesel use than the staff's proposed ADF regulation but do so with equal cost-effectiveness. (Equal cost-effectiveness means that the dollars spent per unit mass of NOx emissions eliminated will be the same.) Given that the Growth Energy alternative provides greater environmental benefits, which in turn substantially lessen the ADF's significant impacts, and is equally cost-effective as the staff's proposed ADF regulation, the Growth Energy Alternative rather than the staff proposal should be adopted by CARB.

ADF 17-47

Background

On July 29, 2014, CARB published a "Solicitation of Alternatives for Analysis in the Alternative Diesel Fuel Standardized Regulatory Impact Assessment" which is attached. On August 15, 2014, Growth Energy submitted an alternative regulatory proposal for the ADF regulation (which is attached) to CARB in response to the agency's solicitation. On December 30, 2014, CARB staff published both the ISOR for the ADF regulation as well as a document entitled "Summary of DOF Comments to the Combined LCFS/ADF SRIA and ARB Responses" which is Appendix E to the ADF ISOR, both of which include information related to staff's decision to reject the alternative to the ADF regulation proposed by Growth Energy.

The staff's assessment of the Growth Energy (GE) Alternative published in Appendix E of the ADF ISOR is as follows (emphasis added):

ADF 17-48

> ***Benefits:***
>
> ***ARB finds that the GE alternative would meet the emissions goals of the ADF proposal and achieve roughly the same emissions benefits as the ADF proposal. The GE alternative may achieve marginally more emissions benefits if biodiesel were to be widely used as an additive under the ADF proposal. Although the GE alternative is simpler than the ADF proposal, the GE alternative is unnecessarily strict; ARB's analysis of the science does not find that there are NO_X increases with B5 animal biodiesel or biodiesel used in NTDEs, so***

requiring mitigation for these does not achieve any additional emissions benefit versus the ADF proposal.

Costs:

The GE alternative would require mitigation of more fuel than the ADF proposal; regulated parties would incur more costs to mitigate non-animal- and animal-based biodiesel similarly and setting the significance level for both at one percent. Additionally, the NTDE exemption would increase the volumes of fuels to be mitigated, further increasing the direct costs on regulated parties.

Economic Impacts:

The REMI results also indicate that the combined LCFS/ADF proposal has no discernible difference from the GE alternative. Employment, GSP, and output differ only slightly and represent a difference of less than one tenth of one percent. Given that the GE alternative has higher direct costs, the combined LCFS/ADF alternative is preferred.

Cost-Effectiveness:

ADF 17-49

The GE alternative costs more than the ADF proposal, because it requires mitigation of more biodiesel than the ADF proposal. The GE alternative does not result in any more emissions reductions than the ADF proposal and as such is less cost effective than the ADF proposal.

Reason for Rejection:

ARB rejects the GE alternative because it costs more than the ADF proposal and does not achieve additional emissions benefits*.*

The reason for rejection of the Growth Energy (GE) alternative presented in the ADF ISOR itself is as follows:

This alternative proposal retains the same biodiesel NOx mitigation options as the ADF proposal*. However, under the GE alternative, animal and non-animal biodiesel would be treated equally and require NOx mitigation for all biodiesel blends, including blends below B5.* ***ARB rejects this alternative because the costs are significantly higher than the ADF proposal and do not achieve additional emissions benefits.*** *During the development of this regulation, staff considered alternatives to the proposal and determined that the proposal represents the least-burdensome approach that best achieves the objectives at the least cost.*

Finally, it should be noted that the stated intention of the ADF regulation according to CARB staff in the ADF ISOR is as follows (emphasis added):

*The ADF regulation is intended to create a framework for these low carbon diesel fuel substitutes to enter the commercial market in California, **while mitigating any potential environmental or public health impacts**.*

Discussion

As indicated above, the stated reason why CARB staff rejected the Growth Energy alternative to the proposed ADF regulation is because CARB staff believed it would require that actions be taken to mitigate increased NOx emissions from biodiesel under circumstances where CARB staff incorrectly assumed there would no increased emissions due to biodiesel use on under the ADF. However, as is clearly demonstrated in another attachment to the declaration of James M. Lyons,[1] CARB staff's analysis and assumptions of the increases in NOx emissions that will result for the ADF regulation is fatally flawed as is CARB's basis for rejection of the Growth Energy Alternative.

As shown by the Sierra emissions analysis, once the flaws in the CARB emissions analysis are corrected, it becomes clear that the ADF regulation will allow significant and unmitigated increases in NOx emissions to occur throughout California including areas such as the South Coast and San Joaquin air basins which experience the worst air quality in the state. As CARB staff itself admits, the Growth Energy alternative would require mitigation in exactly those areas where CARB staff was lead to believe it was not required based on its flawed emissions analysis. CARB staff also admits the Growth Energy alternative is based on the same mitigation options contained in the ADF regulation, which CARB staff has already determined to be technically feasible and cost-effective. However, the Growth Energy Alternative is superior to the ADF regulation because it expands the conditions under which this mitigation has to be applied in order to eliminate the potential for any increase in NOx emissions due to biodiesel use to a less-than-significant level. The Growth Energy Alternative therefore precludes any adverse environmental impacts due to increased NOx emissions, which is exactly what CARB staff has asserted the ADF regulation is intended to do.

ADF 17-49 cont.

Given that the Growth Energy alternative:

1. Provides complete mitigation of potential NOx emission increases due to biodiesel use under the ADF and any associated adverse environmental impacts; and

2. Relies on the same mitigation strategies proposed by CARB staff which staff has found to be technically feasible and cost-effective,

ADF 17-50

CARB must adopt the Growth Energy alternative as it better achieves the stated project objectives in an equally cost-effective manner.

[1] Review of CARB Staff Estimates of NOx Emission Increases Associated with the Use of Biodiesel in California under the Proposed ADF Regulation.

17_OP_ADF_GE Responses (Page 283 – 285)

122. Comment: **ADF 17-47 through ADF 17-50**

Agency Response:
The responses to these comments are in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

Appendix J

Appendix J

Additional Analysis Required Under the California Environmental Quality Act

A. CARB May Not Ignore the LCFS Regulation's Pre-2015 Impacts

CARB Staff initiated the environmental review process for the LCFS regulation in 2007, and circulated an Initial Statement of Reasons for the proposed regulation in 2009. As explained by the Court in *POET, LLC v. California Air Resources Board* (2013) 218 Cal.App.4th 681 ("*POET*"), CARB subsequently approved that regulation on April 24, 2009, without completing the environmental review process, and impermissibly delegated authority to complete the environmental review process to the Executive Officer. The Court found that CARB's actions violated CEQA, and directed the superior court to issue a writ enjoining enforcement of the LCFS regulation beyond 2013 levels. The writ issued by the superior court requires CARB, prior to its consideration of the LCFS regulation, to evaluate "the potential adverse environmental effect of increased NOx emissions" associated with the "project" (*i.e.*, the LCFS regulations presently being enforced). (Exhibit "1.") To this day, CARB has never performed a legally compliant review of the environmental effects of CARB's existing LCFS regulation.

LCFS 46-261

Although the court in *POET* directed CARB to evaluate the effects of the LCFS regulation, the Environmental Assessment ("EA") for the LCFS regulation and the ADF regulation (the "Proposed Regulations") ignores the impacts of the LCFS regulation presently in effect, as well as any other impacts of the project prior to 2014. As a result, prior to its consideration of the LCFS regulation and the ADF regulation, CARB must substantially revise and recirculate the EA for public review to evaluate the entire project.

LCFS 46-262

1. CARB's Project Description Is Inadequate Because it is Unclear Whether the Existing LCFS Regulation Is Part of the Project

"An accurate, stable and finite project description is the sine qua non of an informative and legally sufficient" environmental document. (*County of Inyo v. City of Los Angeles* (1977) 71 Cal.App.3d 185, 193.) Additionally, the ***entire project*** being proposed must be described in the EIR, and the project description must not minimize project impacts. (*City of Santee v. County of San Diego* (1989) 214 Cal.App.3d 1438, 1450.) As explained in *County of Inyo*:

> A curtailed or distorted project description may stultify the objectives of the reporting process. Only through an accurate view of the project may affected outsiders and public decision-makers balance the proposal's benefit against the environmental cost, consider mitigation measures, assess the advantage of terminating the proposal (*i.e.*, the "no project" alternative) and weigh other alternatives in the balance.

(*County of Inyo v. City of Los Angeles* (1977) 71 Cal.App.3d 185, 192-93.)

LCFS 46-263

The EA violates this mandate. First, the EA is unclear as to whether CARB is treating the "Project" as including the LCFS regulation presently in effect. On the one hand, the EA's project description discusses the existing LCFS regulation; the EA recognizes that the present action is being taken in response to the decision in *POET*; and the "re-adopted" LCFS regulation is structurally nearly identical to the LCFS regulation presently being enforced. On the other hand, however, the EA does not address the environmental effects of the LCFS regulation presently being enforced, and the "carbon intensity" base year has changed from 2010 to 2014. Because it is unclear whether the "project" analyzed in the EA includes the LCFS regulation presently in effect, the project description in the EA is not stable or finite, and is thus inadequate under CEQA.

LCFS 46-263 cont.

To the extent CARB intended to omit the current LCFS regulation from the project description, that action would also result in an inadequate project description because it is "inaccurate." CEQA requires the project description to include ***entire project***, not a smaller piece of the project that would have the impact of minimizing project impacts. (*City of Santee*, *supra*, 214 Cal.App.3d at 1450.) Describing only the "re-adopted" portions of the LCFS regulation also runs directly contrary to the writ issued by the superior court, which specifically requires CARB to analyze the effects of the project presently being implemented. (See Exhibit "1.")

LCFS 46-264

As a result, CARB must revise the project description in the EA to specifically include the existing LCFS regulation, and analyze the impacts associated with the existing regulation.

LCFS 46-265

2. <u>The Baseline Used By CARB Is Unclear</u>

Because the impacts of a project are evaluated against the environmental baseline, determining the proper baseline is critical to a meaningful discussion of the project's environmental impacts. (See *Communities for a Better Environment v. South Coast Air Quality Mgmt. Dist.* (2010) 48 Cal.4th 310, 320.) The EA here obscures the baseline used by CARB for its analysis of the impacts of the regulations because there is no definitive statement explaining what specific baseline is being used in the EA. Rather, the portion of the EA that purportedly sets forth the baseline cites to an appendix to the EA, which discusses the "Environmental and Regulatory Setting" of the Regulations. But even this appendix does not specifically state what date the EA is using as the baseline for environmental review. As a result, the EA should be revised to specifically state what baseline it is using, and recirculated for public review.

LCFS 46-266

3. Ignoring Pre-2014 Impacts Results in an Improper Baseline for <u>Environmental Review</u>

Generally, the "environmental baseline" includes the environmental conditions as they exist at the time the lead agency publishes the Notice of Preparation ("NOP") for the project, or, if there is no NOP, as is the case here, "at the time the environmental analysis is commenced." (CEQA Guidelines, § 15125(a).) Although the EA does not specifically state what baseline is being used, the analysis in the EA ignores the LCFS regulation's impacts prior to 2014, and asserts that the analysis in the EA "addresses the potentially significant adverse environmental impacts resulting from implementing the proposed LCFS and ADF regulations

LCFS 46-267

compared to existing conditions, **which include existing compliance with the LCFS left in place by the Court at the 2013 regulatory standards**." (EA at 3 [emphasis added].)

LCFS 46-267 cont.

Omitting analysis of the project's pre-2014 impacts is improper. Here, the environmental review commenced in 2007, and the initial Staff Report/ISOR for the LCFS regulation was released in 2009. As a result, the proper baseline for environmental review under CEQA is 2007, and certainly no later than 2009. (CEQA Guidelines, § 15125(a).)

LCFS 46-268

To the extent CARB intends to use a baseline of 2014, that baseline is also impermissible because it is "misleading" and obscures the impacts of the Regulations. (See, e.g., *Neighbors for Smart Rail v. Exposition Metro Line Construction* (2013) 57 Cal.4th 439.) Specifically, NOx emissions caused by the existing LCFS regulation from 2011 through 2014 from the San Joaquin Valley, the South Coast air basin, and the entire state, respectively, total 782, 1,032, and 3,463 tons per year. (Decl. Lyons at E-4.) Because a 2014 baseline has the effect of essentially sweeping prior NOx emissions under the rug, it is misleading, and a more accurate baseline should be used.

LCFS 46-269

The fact that the emissions occurred in the past does not excuse CARB from analyzing the effects of those emissions, as CARB still has the ability to mitigate these emissions, or modify the LCFS regulation in response to its analysis. In *Bakersfield Citizens for Local Control*, for example, the court set aside an EIR for a large commercial development, including a Wal-Mart. The trial court enjoined the construction of the Wal-Mart, but let the remainder of the construction proceed, and those businesses were operating at the time the court of appeal heard the case. The agency asserted the environmental review for the other businesses was moot because those businesses were operational. The Fifth District Court of Appeal disagreed, finding:

> [E]ven at this late juncture full CEQA compliance would not be a meaningless exercise of form over substance. The City possesses discretion to reject either or both of the shopping centers after further environmental study and weighing of the projects' benefits versus their environmental, economic and social costs. As conditions of reapproval, the City may compel additional mitigation measures or require the projects to be modified, reconfigured or reduced. The City can require completed portions of the projects to be modified or removed and it can compel restoration of the project sites to their original condition.

LCFS 46-270

(*Bakersfield Citizens for Local Control v. City of Bakersfield* (2004) 124 Cal.App.4th 1184, 1204.) In other words, "[a]s a matter of public policy and basic equity, developers should not be permitted to effectively defeat a CEQA suit merely by building out a portion of a disputed project during litigation . . . ." (*Id.* at 1203.) By ignoring pre-2014 NOx emissions, CARB is seeking to do just that.[1]

[1] CARB also cannot rely upon the rule that the baseline for a previously-reviewed project assumes the previously-approved project exists. (See Remy, Thomas, Moose & Manley, *Guide to CEQA* (11th ed. 2007) at 207.) This is because the Court in *POET, LLC v. California Air Resources Board* invalidated CARB's environmental document for the original LCFS regulation.

Because the EA employs the wrong baseline, the EA should be revised, and recirculated for public review.

LCFS 46-271

4. By Failing to Address Pre-2014 NOx Emissions, the EA Is Deficient Because it Does Not Analyze Cumulative Impacts

Even if CARB could argue the existing LCFS regulation was a different "project" under CEQA, CARB in its EA would still need to address the impacts of that regulation as "cumulative impacts." This is because CEQA requires that the environmental document discuss the cumulative effect on the environment of the subject project in conjunction with other closely-related ***past***, present, and reasonably foreseeable probable future projects. (See, e.g., Pub. Resources Code, § 21083, subd. (b).) "The purpose of this requirement is obvious: consideration of the effects of a project or projects as if no others existed would encourage the piecemeal approval of several projects that, taken together, could overwhelm the natural environment and disastrously overburden the man-made infrastructure and vital community services. This would effectively defeat CEQA's mandate to review the actual effect of the projects upon the environment." (*Citizens to Preserve the Ojai v. County of Ventura* (1985) 176 Cal.App.3d 421, 432.) Thus, regardless of whether the original LCFS regulation and the proposed LCFS regulation constituted different projects, CARB cannot avoid analyzing pre-2014 impacts as cumulative impacts.

LCFS 46-272

5. CARB's Failure to Analyze Pre-2014 Impacts Constitutes Improper Segmentation/Piecemealing

Ignoring the impacts of the existing regulation also impermissibly piecemeals the analysis of the impacts of the LCFS regulation. CEQA prohibits a lead agency from piecemealing – or segmenting – the environmental review of a project; in other words, a lead agency may not break up an action into several small "projects" that would have the effect of minimizing environmental review. "The requirements of CEQA cannot be avoided by piecemeal review which results from "chopping a large project into many little ones-each with a minimal potential impact on the environment-which cumulatively may have disastrous consequences." (*Lighthouse Field Beach Rescue v. City of Santa Cruz* (2005) 131 Cal.App.4th 1170, 1208-09 [quoting *Bozung v. LAFCo* (1975) 13 Cal.3d 263, 283-84]; see also *Environmental Protection Info. Ctr. v. Calif. Dept. of Forestry & Fire Prot.* (2008) 44 Cal.4th 549, 503.) In other words, where "an individual project is a necessary precedent for action on a larger project," the environmental review performed by the public agency "***must*** address itself to the scope of the larger project." (Cal. Code Regs., § 15165 [emphasis added].)

LCFS 46-273

As explained previously, NOx emissions caused by the LCFS regulation from 2011 through 2014 from the San Joaquin Valley, the South Coast air basin, and the entire state, respectively, total 782, 1,032, and 3,463 tons per year. (Decl. Lyons at E-4.) These past emissions – caused directly by the LCFS regulation that remains in effect – are troubling, due to among other things the U.S. EPA's recent redesignation of the San Joaquin Valley as an "extreme" non-attainment area for NOx. (75 Fed. Reg. 24409.) Estimated NOx emissions in the San Joaquin Valley caused by the existing version of the LCFS regulation total approximately 2.39 tons per day (or 872.35 tons per year) in 2020. (Decl. Lyons at D-10 [Figure 1c], F-18 [Table 8].) This is far higher than the San Joaquin Valley Air Pollution Control District's (the "District") adopted threshold of significance for NOx, which explain that a "project" under

CEQA is considered to have a significant impact on air quality if it would cause NOx emissions to exceed 10 tons per year.[2]

The EA makes no mention of these past increases, despite the fact that under the proposed LCFS regulation considered for "re-adoption" and the ADF regulation, statewide NOx emissions from biodiesel are projected to increase. (ADF ISOR at 42.) To fully consider and evaluate the potential significant impacts of the LCFS regulation and the ADF regulation, CARB may not look at the post-2014 emissions in isolation. Rather, by "chopping" the LCFS regulation into two smaller pieces, and obscuring the environmental impacts of the Regulations in the process, CARB is seeking to impermissibly piecemeal environmental review of the project. (*Lighthouse Field, supra*, 131 Cal.App.4th at 1208-09.)

LCFS 46-273 cont.

B. The EA's Analysis of Criteria Pollutant Emissions, Including NOx, Is Incomplete

NOx is one of the most important smog-forming emissions from man-made sources in some areas of California, including the San Joaquin Valley. Progress in reducing smog depends largely upon reductions of NOx, or "oxides of nitrogen," which are considered "major contributors to smog formation and acid deposition." (17 C.C.R., § 93118(d)(19).) NOx contributes to the formation of ground-level ozone (smog) in the San Joaquin Valley, particularly during the summer months. (*Calif. Building Indus. Ass'n v. San Joaquin Valley Air Pollution Control Dist.* (2009) 178 Cal.App.4th 120, 126 ["*CBIA*"].) The San Joaquin Valley air basin does not meet the federal ozone standard required under the Clean Air Act; the area has thus been designated by EPA as "extreme non-attainment" for ozone under the federal National Ambient Air Quality standards ("NAAQs"). (75 Fed. Reg. 24409.)

LCFS 46-274

1. The EA Fails to Analyze or Discuss Criteria Pollutants Other than NOx

The EA contains only a minimal discussion of impacts associated with criteria pollutants. (See EA at 51-52.) The EA only quantifies the emissions associated with one criteria pollutant: NOx. There is no discussion of other criteria pollutants, including particulate matter (PM), volatile organic compounds (VOCs), and reactive organic gases (ROG).

Whether CARB believes these impacts are insignificant is irrelevant. CEQA places the burden of environmental investigation on government rather than the public," and a lead agency "should not be allowed to hide behind its own failure to gather data." (See, e.g., *Sundstrom v. County of Mendocino* (1988) 202 Cal.App.3d 296, 311.) By failing to analyze the impacts of the proposed "re-adopted" LCFS regulation and the ADF regulation on criteria pollutants, other than NOx, the EA does not comply with CEQA.

LCFS 46-275

[2] San Joaquin Valley Air Pollution Control Dist., Guide for Assessing and Mitigating Air Quality Impacts (1998; Jan. 2002 rev.) § 4, Table 4-1, p. 26 (the "SJVAPD Guide"), *available at* http://www.valleyair.org/transportation/CEQA%20Rules/GAMAQI%20Jan%202002%20Rev.pdf

2. The Project Will have Significant Impacts Associated With NOx Emissions, Even Using CARB's Own Analyses

Although the EA estimates that NOx emissions will decrease over time, CARB itself estimates that increased use of biodiesel associated with the ADF regulation and the "re-adopted" LCFS regulation will result in additional NOx emissions of 1.29 tons per day [or 470.85 tons per year] in 2015. (ADF ISOR, Table B-1.) Although CARB's estimated increases in NOx are inaccurate, and drastically understate NOx emissions, as explained *infra*, an increase in NOx emissions of 470.85 tons per year is in itself significant, and CARB cannot plausibly claim the Projects' impacts will have "beneficial" impacts on operational criteria pollutant emissions. LCFS 46-276

Any attempt by the EA to offset, or mitigate, biodiesel NOx emissions with the use of renewable diesel fuel is erroneous. There is "nothing in either the proposed ADF regulation or the proposed LCFS regulation that mandates the use of any volume of biodiesel in California, much less the use of the exact ratio of renewable diesel to biodiesel assumed by CARB staff in its emissions analysis." (Decl. Lyons, at D-4.) Despite this, the EA does not include any analysis of the possibility that renewable diesels will not displace biodiesels at the rate contemplated in the ISOR. Thus, any alleged off-set is speculative, and does not excuse CARB's failure to analyze NOx increases associated with biodiesel, or to mitigate the 470.85 tons per year in emissions increased use of biodiesel will generate. LCFS 46-277

Moreover, none of the documents made available for public review by CARB (including the EA, the two ISORs, or the supporting materials) support staff's assertion "that 40% of renewable diesel used in California will be used by refiners to aid in compliance with CARB's existing diesel fuel regulations and that 60% will be blended downstream of refineries." (*Id.*) Indeed, this result defies common sense; to the extent fuel producers choose to blend renewable diesel in California, it would be far more logical for "them to do so by purchasing renewable diesel for use at their refineries where they can benefit from the other desirable properties of this fuel beyond its low carbon intensity (CI) value (e.g., high cetane number and fungibility with diesel fuel at all blend levels)," as opposed to "purchasing LCFS credits generated by downstream blenders of renewable diesel fuel." (*Id.*) LCFS 46-278

The Regulations will have significant impacts resulting from the emission of NOx caused by increase biodiesel usage. As a result, the EA's finding that the Regulations would have a "beneficial" effect to criteria pollutant emissions is erroneous, and not supported by substantial evidence. LCFS 46-279

3. The Analysis of NOx Impacts Is Flawed and Incomplete, and Omits Known Sources of Emissions

The EA's analysis significantly understates the true impacts associated with operational NOx emissions. CARB staff's calculation of NOx emissions associated with increased biodiesel usage was based on the erroneous assumption that biodiesel use in "New Technology Diesel Engines" (NTDEs) at levels up to B20 will not increase NOx emissions. As explained in the Declaration of James M. Lyons, the available data demonstrate "not only that NOx emissions from NTDEs will increase with the use of biodiesel in proportion to the amount LCFS 46-280

of biodiesel present in the blend, but also that the magnitude of the increase on a percentage basis will be much greater than that observed for 'legacy vehicles.'" (Decl. Lyons, at D-4.)

Specifically, "if one simply and extremely conservatively assumes that NTDE NOx increases will be the same on a percentage basis as legacy vehicles and eliminates the NOx offsets assumed from renewable diesel, the NOx increases expected from biodiesel increase from 1.36 tons per day statewide in 2014 to approximately 3.44 tons per day—a factor of about 2.65." (Decl. Lyons, at D-4; see also ADF ISOR, Table B-1.) "For 2023, estimated NOx emission increases due to biodiesel rise to about 0.87 tons per day . . . ." (*Id.* at D-4, D-5.) Thus, accounting for NOx emissions associated with NTDEs alone, projected NOx emissions are far greater than those calculated by CARB staff.

By performing a detailed and comprehensive – yet conservative – analysis of NOx increases using generally accepted techniques, Sierra Research has concluded that NOx emissions are far more severe, and could total as much as 9.73 tons per day statewide in 2020, and 2.39 tons per day (or 872.35 tons per year) in 2020 in the San Joaquin Valley air basin alone. (Decl. Lyons at D-10 [Figure 1c], D-18 [Table 8].) This figure is vastly higher than the 10 tons per year threshold of significant adopted by the San Joaquin Valley Air Pollution Control District for projects under CEQA. (See SJVAPD Guide, § 4, Table 4-1, p. 26.)

LCFS 46-280 cont.

4. The EA Fails to Quantify Impacts Associated With the Construction Of New Facilities

The EA posits that the Regulations would result in the construction of new or modified fuel production facilities to meet demand for fuels created by the Regulations, including processing plants for agriculture-based ethanol, cellulosic ethanol, and biomethane. Without quantifying the potential impacts of these facilities, the EA makes the bare conclusion that several of the impacts associated with these facilities would be "significant and unavoidable."

An environmental document, including a functional equivalent document, however, cannot simply label an impact "significant and unavoidable" without first providing a discussion and analysis. Such a backwards approach "allows the agency to travel the legally impermissible easy road to CEQA compliance." (*Berkeley Keep Jets Over the Bay Comm. v. Bd. of Port Comm'rs* (2001) 91 Cal.App.4th 1344, 1370.) Rather, the lead agency must quantify the impact, and consider feasible mitigation based on that analysis. (See, e.g., *Sundstrom*, *supra*, 202 Cal.App.3d at 311 ["CEQA places the burden of environmental investigation on government rather than the public," and a lead agency "should not be allowed to hide behind its own failure to gather data."].)

The potential impacts associated with the development of new or modified facilities *can* be quantified. As explained in the Declaration of James M. Lyons, CARB attempted to quantify emissions from such facilities in its 2009 rulemaking. (Decl. Lyons at B-3.)

LCFS 46-281

Moreover, by declining to quantify impacts associated with new facilities, the EA essentially forecloses any and all mitigation measures. For example, if potential criteria pollutant emissions were quantified, CARB could modify the proposed regulation, enact another

LCFS 46-282

regulation, or otherwise develop mitigation to reduce such impacts. CARB could also reconfigure the Regulations, create performance standards for new California biodiesel facilities, or otherwise create disincentives to develop new facilities within California. Instead, however, the EA merely provides a laundry list of *potential* mitigation measures, without actually requiring that those mitigation measures be implemented, or analyzing whether those mitigation measures would reduce the impacts to a less-than-significant level.

LCFS 46-282 cont.

5. The Increased NOx Emissions Under the Regulations Violate AB32

NOx emissions caused by the Regulations also violate AB 32. Health and Safety Code Section 38570, subdivision (b), requires CARB, "***[p]rior to*** the inclusion of any market-based compliance mechanism in the regulations," to "(1) [c]onsider the potential for direct, indirect, and cumulative emission impacts from these mechanisms, including localized impacts in communities that are already adversely impacted by air pollution," and "(2) [d]esign any market-based compliance mechanism *to* ***prevent any increase*** in the emissions of toxic air contaminants or criteria air pollutants." (Health & Saf. Code § 38570, subd. (b) [emphasis added]. In addition, for any regulation adopted under AB32 like the LCFS regulation, the Board must "***ensure*** . . . activities undertaken pursuant to the regulations do not interfere with . . . efforts to achieve and maintain federal and state ambient air quality standards" (*Id.* § 38562(b)(4); emphasis added)].) Because the Regulations would ***increase*** NOx emissions from biodiesel, the Regulations are unlawful.

LCFS 46-283

C. The Mitigation Measures Proposed in the EA Inadequate Under CEQA

The Mitigation Measures specified in the EA are also inadequate under CEQA. The EA finds that several potential impacts of the Regulations would be "significant and unavoidable," resulting from the construction of new or modified facilities to meet demand for fuels created by the Regulations, including processing plants for agriculture-based ethanol, cellulosic ethanol, and biomethane. Rather than including enforceable mitigation, however, the EA merely sets forth "recognized practices" that are "routinely required" to avoid or minimize impacts, without requiring the implementation of any specific measure, or even evaluating whether any such measures – if incorporated – would actually reduce or minimize the impact. This is improper under CEQA for several reasons.

LCFS 46-284

First, mitigation must be enforceable. (Pub. Resources Code, § 21081.6, subd. (b); CEQA Guidelines, § 15126.4(a)(2).) The EA, however, does not require any particular measure. Rather, the EA just sets forth a potential mitigation measures that local land use authorities *could* implement if they choose to do so. Because none of the mitigation measures identified in the EA are enforceable, they are inadequate under CEQA.

LCFS 46-285

Mitigation must also be effective, and an agency must identify mitigation measures that will minimize the project's significant impacts by reducing or avoiding them. (See, e.g., Pub. Resources Code, §§ 21001, 21100.) The EA, however, does not discuss *how* any of the proposed mitigation measures – if implemented – would reduce or avoid the potential impacts of the Regulation, and if so, to what degree.

LCFS 46-286

Nor may CARB permissibly defer the formulation of specific mitigation. To defer mitigation, a lead agency must still (1) "evaluate[] the potentially significant impacts of the

LCFS 46-287

project," (2) "identif[y] measures that will mitigate those impacts," (3) "commit[] to the mitigating the significant impacts of the project," and (4) "specify performance standards which would mitigate the significant effect of the project" to govern the subsequent mitigation. (*California Native Plant Soc'y v. City of Rancho Cordova* (2009) 172 Cal.App.4th 603, 621.) Here, in contrast, the EA does not specifically identify the potential impacts, require the mitigation of significant impacts, or "specify performance standards which would mitigate the significant effect of the" Regulations. (See *id.*)

LCFS 46-287 cont.

As a result, CARB must revise the EA to further analyze potential mitigation measures, and include enforceable mitigation to minimize the recognized potentially significant impacts of the Regulations, and recirculate the revised EA for public review.

LCFS 46-288

D. <u>The EA Fails to Analyze Impacts Associated With Fuel Shuffling</u>

Since its enactment in 2009, the LCFS regulation has led to a phenomenon called "fuel shuffling," in which lower-CI fuels are shipped from around the world to California and higher-CI fuels must be sent for sale elsewhere. (Decl. Lyons at B-4.) CARB has admitted that fuel shuffling will occur. (See, e.g., December 2009, Final Statement of Reasons at 241.) There is no environmental advantage to fuel shuffling, for the same fuels are still produced and consumed, and the same GHGs are still emitted from those processes. Rather, because the LCFS regulation encourages the shipment of fuels to alternative locations that are further from origin facilities, fuel shuffling actually causes emissions of GHGs to increase.[3]

These increases in emissions are potentially significant, but discussed nowhere in the EA. For example, even using CARB's direct emissions model (GREET), GHG emissions associated with shuffling would be significant. For example, the LCFS regulation will likely result in higher amounts of Brazilian cane ethanol being shipped to California, with more traditional fuels being shipped from California to Brazil and other destinations by ship. Additional shipping corn- and sugarcane-based ethanol by ship to and from destinations such as Brazil alone would result in an additional 150,000 tons per year of CO2 equivalent emissions. (Appendix G) Using more accurate direct emission models, increase CO2 equivalent emissions would be between 385,000-735,000 tons per year – or nearly 4.5% of the total emissions benefits CARB assets the Regulations would allegedly cause. (Appendix G) Notably, these figures do not include increases in emissions associated with fuel shuffling of crude oils, or the increases in the transport of ethanol by rail as part of fuel shuffling. (Appendix G)

LCFS 46-289

The EA likewise does not evaluate whether fuel shuffling caused by the Regulations would result in additional increases in criteria pollutant emissions. Because transportation of fuels by rail, truck, and sea indisputably create emissions of criteria pollutants, both inside and outside[4] California, the EA must analyze those potential impacts to determine

LCFS 46-290

[3] Because the LCFS regulation will not achieve any benefits as to climate change, CARB cannot base any statement of overriding considerations on this assertion.

[4] CARB must analyze both in-state and out-of-state impacts caused by the Regulation. CEQA defines "environment" to include "the physical conditions that exist within the area which will be affected by a proposed project, including land, air, water, minerals, flora, fauna, noise, or objects of historic or aesthetic significance." (Public Resources Code, § 21060.5.) That definition includes no geographic limitation. We also understand CARB has considered out-of-state impacts in previous rulemakings.

whether they are significant. (See, e.g., *Sundstrom*, *supra*, 202 Cal.App.3d at 311 ["CEQA places the burden of environmental investigation on government rather than the public," and a lead agency "should not be allowed to hide behind its own failure to gather data."].)

LCFS 46-290 cont.

Thus, to accurately identify and analyze the impacts of the Regulations, the EA must be revised to address impacts associated with fuel shuffling, and recirculate the EA for public review.

LCFS 46-291

E. The EA's Discussion of the Growth Energy Alternative Is Insufficient

The requirement that environmental documents identify and discuss alternatives to the project stems from the fundamental statutory policy that public agencies should require the implementation of feasible alternatives or mitigation measures to reduce the project's significant impacts. (See, e.g., Pub. Resources Code, § 21002.) The lead agency must focus on alternatives that can avoid or substantially lessen a project's significant environmental effects. (See *id.*) The EA here impermissibly rejects discussion of the Growth Energy Alternative, and does not include any discussion of a Cap and Trade Alternative. These alternatives are discussed in greater detail below. The CEQA Guidelines specifically recognize that comments raised by members of the public on an environmental document are particularly helpful if they suggest "additional specific alternatives . . . that would provide better ways to avoid or mitigate the significant environmental effects." (CEQA Guidelines, § 15204.)

LCFS 46-292

The Growth Energy Alterative contemplates an adjustment to the cap and trade regulation in Title 17 of the California Code of Regulations to account for whatever increment of GHG emissions reductions would be foregone by eliminating the LCFS regulation. CARB concedes the Growth Energy Alternative would achieve the same emissions reductions contemplated under the Regulations. (See Standardized Regulatory Impact Assessment at 26-27.)

LCFS 46-293

The Growth Energy Alternative also would not result in fuel shuffling, or the construction of numerous fuel production plants in California. (See Decl. Lyons at B-4.) Because the only impacts found to be "significant and unavoidable" under the EA result from the construction of new and modified fuel production facilities, the Growth Energy Alternative would likely eliminate ***all*** of the Regulations' significant and unavoidable impacts. Because the Growth Energy Alternative would lessen the "significant and unavoidable" effects of the Regulations, it should be included as an alternative in a recirculated EA. (Pub. Resources Code, § 21002.)

LCFS 46-294

Despite these benefits, the EA rejects the Growth Energy Alternative to the Regulations because it would allegedly require that actions be taken to mitigate increased NOx emissions from biodiesel under circumstances where CARB staff incorrectly assumed there would be no increased emissions due to biodiesel use under the ADF. These assumptions are flawed.

LCFS 46-295

As demonstrated by Sierra Research, the ADF regulation will result in significant and unmitigated increases in NOx emissions throughout California, including significant impacts within the San Joaquin Valley and South Coast air basins. (Decl. Lyons ¶ 15.) The EA concedes the mitigation proposed under the Growth Energy Alternative would require "mitigation in

exactly those areas where CARB staff was lead to believe it was not required based on its flawed emissions analysis." (Decl. Lyons at G-3.) Because of this, and the fact that the Growth Energy Alternative expands the conditions under which this mitigation has to be applied in order to eliminate the potential for any increase in NOx emissions due to biodiesel use, the Growth Energy Alternative is environmentally superior to the ADF regulation. (*Id.*)

LCFS 46-295 cont.

To the extent CARB argues the Growth Energy Alternative does not meet the objective of "greater innovation and development of cleaner fuels," this is not a valid reason to reject discussion of the alternative. First, as explained in the Declaration of James M. Lyons, the Growth Energy Alternative would also foster greater innovation and development of cleaner fuels in California because most of the same fuels will be blended into California fuels as a result of the federal RFS program. (Decl. Lyons at C-4.)

But even if the Growth Energy Alternative would not meet this project objective, (see ISOR at E-40, E-41), CARB may not simply reject discussion of an alternative simply because it does not meet one of several project objectives. Rather, a feasible alternative that would substantially reduce the project's significant impacts should not be excluded from the analysis simply because it would not fully achieve the project's objectives. (See *Habitat & Watershed Caretakers v. City of Santa Cruz* (2013) 213 Cal.App.4th 1277, 1304.) Here, as discussed above, the Growth Energy Alternative would essentially eliminate all of the "significant and unavoidable" impacts of the Regulations.

LCFS 46-296

Further, to the extent CARB relies upon this objective to reject mere analysis of the Growth Energy Alternative, this is improper because it would essentially limit the range of alternatives described to regulations that are nearly identical to the Regulations. Because agencies may not "give a project's purpose an artificially narrow definition," (*In re Bay-Delta Programmatic Envt'l Report Coordinated Proceedings* (2008) 43 Cal.4th 1143, 1166), and CARB has previously demonstrated a pattern of prejudging the LCFS regulation prior to completing the environmental review process, (see *POET, LLC v. California Air Resources Board* (2013) 218 Cal.App.4th 681), CARB should not artificially tailor its objectives to limit the range of alternatives to the LCFS regulation itself.

LCFS 46-297

In short, the Growth Energy Alternative better achieves the project objectives than the Regulations, and is environmentally superior to the Regulations. As a result, the EA must analyze the Growth Energy Alternative, and CARB must recirculate the EA for public comment.

LCFS 46-298

F. CARB Must Substantially Revise the LCFS Regulation, the ADF Regulation, And the EA, Due to Material Inconsistencies Between the Two Regulations

As explained in detail in the Declaration of James M. Lyons, the LCFS regulation and the ADF regulation "contain inconsistent and conflicting definitions," and lack "provisions requiring the determination, through testing, of the biodiesel content of commercial blendstocks." (Decl. Lyons ¶ 17.) These inconsistencies include that: (1) the Regulations contain different definitions for the term "biodiesel"; (2) the term "Biodiesel Blend" under the LCFS regulations contains at least 6% biodiesel, while a "Biodiesel Blend" under the ADF is a diesel fuel containing any biodiesel; (3) the LCFS regulation defines "Diesel Fuel Blend" as a blend of diesel fuel and up to 5% biodiesel, while such a fuel would be considered "CARB diesel" under the ADF regulation; and (4) under the proposed ADF regulation, "B20" is

LCFS 46-299

nonsensically defined as a fuel that contains between 6% and 20% biodiesel, which directly contradicts the definition of "Blend Level" in same regulation. (See Decl. Lyon at H-3, H-4.)

In addition, the term "Biodiesel Blend" is defined in the ADF regulation as a mixture of biodiesel and an undefined fuel referred to as "petroleum-based CARB diesel." "Blend Level" applies to blends of all fuels subject to the ADF regulation, including biodiesel, and is defined as the ratio of an "Alternative diesel fuel" mixed with "CARB diesel." As noted above, however, "CARB diesel" may already contain as much as 5% biodiesel under the proposed ADF regulation. The addition of biodiesel to a fuel already containing some amount of biodiesel up to 5% will cause the actual biodiesel content to be higher than the blender expects, which in turn will result in increased NOx emissions. (See Decl. Lyons at F-3, F-4.) These potential NOx emissions are not discussed in the EA.

The internal inconsistencies between the LCFS regulation and the ADF regulation also render the project description defective. "An accurate, stable and finite project description is the sine qua non of an informative and legally sufficient EIR." (*County of Inyo v. City of Los Angeles* (1977) 71 Cal.App.3d 185, 193.) Because the LCFS regulation and the ADF regulation contain material, conflicting terms, the project description is not accurate or stable, and must be revised.

Due to these material inconsistencies, the EA is legally flawed. Both the proposed regulations and the EA must be revised significantly, and recirculated for public review.

LCFS 46-299 cont.

17_OP_ADF_GE Responses (Page 286 – 299)

123. Comment: **LCFS 46-261 through LCFS 46-299**

Agency Response:
The responses to these comments are in “Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.”

17_OP_ADF_GE Responses (Page 300 – 304)

124. Comment: **Writ of Mandate**

Agency Response: The Writ of Mandate does not constitute an objection or suggestion on the proposal.

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Comment letter code: 18-OP-ADF-GE

Commenter: Joshua Willter

Affiliation: Growth Energy

The following letter was submitted to the ADF Docket during the 45-day comment period.

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18_OP_ADF_GE Responses

125. Comment: **ADF 18-1**
The commenter included the following materials with its comment letter:

1. Air Resources Board. (2014). Annual Research Plan: Fiscal Year 2015-2016. **(2.pdf)**

2. Air Resources Board. (2015). Proposed Regulation on the Commercialization of Alternative Diesel Fuels, Staff Report: Initial Statement of Reasons. January 2015. **(1.pdf)**

3. Air Resources Board. (2009). Proposed Regulation to Implement the Low Carbon Fuel Standard. Volume II, Appendices. **(1.pdf)**

4. Andreae, M.O. & Merlet, P. (2001). *Emission of Trace Gases and Aerosols from Biomass Burning*. Global Biogeochemical Cycles, Volume 15, No. 4, pp.955-966. December 2001. **(Emissions_Trace_Gas_from_Biomass_Burning.pdf)**

5. Anuario Estatistico de Energia Electria 2014: ano base 2013, versao "workbook" – dados preliminares. (2014). [Spreadsheet from http://www.epe.gov.br]. **(Anuario Estatistico de Energia Electrica 2014.xlsx)**

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Agency Response:
The comment letter contains 63 references that were cited in Comment Letter 18_OP_ADF_GE. None of these materials contain objections to or recommendations concerning ARB's proposed regulation, so response specific to these materials are not provided. ARB has separately responded to the comments that may rely on these materials.

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Comment letter code: 19-OP-ADF-GE

Commenter: Joshua Willter

Affiliation: Growth Energy

The following letter was submitted to the ADF Docket during the 45-day comment period.

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19_OP_ADF_GE Responses

126. Comment: **ADF 19-1**
The commenter included the following materials with its comment letter.

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Agency Response:

The comment letter contains 19 references that were cited in Comment Letter **19_OP_ADF_GE.** None of these materials contain objections to or recommendations concerning ARB's proposed regulation, so response specific to these materials are not provided. ARB has separately responded to the comments that may rely on these materials.

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Comment letter code: 20-OP-ADF-GE

Commenter: Joshua Willter

Affiliation: Growth Energy

The following letter was submitted to the ADF Docket during the 45-day comment period.

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20_OP_ADF_GE Responses

127. Comment: **ADF 20-1**
The commenter included the following materials with its comment letter.

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Agency Response:
The comment letter contains one reference that was cited in Comment Letter **20_OP_ADF_GE**. None of these materials contain objections to or recommendations concerning ARB's proposed regulation, so response specific to these materials are not provided. ARB has separately responded to the comments that may rely on these materials.

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Comment letter code: 21-OP-ADF-GE

Commenter: Joshua Willter

Affiliation: Growth Energy

The following letter was submitted to the ADF Docket during the 45-day comment period.

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21_OP_ADF_GE Responses

128. Comment**:** **ADF 21-1**
The commenter included the following materials with its comment letter.

1. "Appendix A. Comparison of fuel detail for the State Energy Data System and the Annual and Monthly Energy Review data systems." (no date). **(appendixa.pdf)**[3]

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9. U.S. Energy Information Administration. (no date). "Table 6. Energy intensity by State (2000-2011)." **(table6.pdf)**[9]

10. U.S. Energy Information Administration. (no date). "Table 7. Carbon intensity of the energy supply by State (2000-2011)." **(table7.pdf)**[10]

[3] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[4] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[5] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[6] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[7] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[8] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[9] Duplicate of reference submitted under Comment #47 – Part 2 of 6.

11. U.S. Energy Information Administration. (no date). “Table 8. Carbon intensity of the economy by State (2000-2011).” **(table8.pdf)**[11]

12. U.S. Energy Information Administration. (no date). “Table 9. Net electricity trade index and primary electricity source for selected States.” (2000-2011).” **(table9.pdf)**[12]

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18. U.S. Environmental Protection Agency. (2013). Regulatory Announcement: EPA Issues Final Rule for Additional Qualifying Renewable Fuel Pathways under the RFS2 Program. EPA-420-F-13-014. February 2013. **(420f13014.pdf)**

[10] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[11] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[12] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[13] Duplicate of reference submitted under Comment #47 – Part 2 of 6.
[14] Duplicate of reference submitted under Comment #47 – Part 2 of 6.

19. U.S. Environmental Protection Agency. (2012). Regulatory Announcement: EPA Issues Supplemental Determination for Renewable Fuels Produced under the Final RFS2 Program from Grain Sorghum. EPA-420-F-12-078. November 2012. **(420f12078.pdf)**

20. U.S. Environmental Protection Agency. (2011). Regulatory Announcement: EPA Issues Direct Final Rule for Additional Qualifying Renewable Fuel Pathways Under the RFS2 Program. EPA-420-F-11-043. November 2011. **(420f11043.pdf)**

21. U.S. Environmental Protection Agency. (2010). Regulatory Announcement: EPA Finalized Regulations for the National Renewable Fuel Standard Program for 2010 and Beyond. EPA-420-F-10-007. February 2010. **(420f10007.pdf)**

22. Wigley, T. M. L. (2008). MAGICC/SCENGEN 5.3: Operator Instructions. Abbreviated from the MAGICC/SCENGEN 5.3 User Manual. NCAR, Boulder, CO. September 2008. **(3.pdf)**[15]

Agency Response:

The comment letter contains 22 references that were cited in Comment Letter **21_OP_ADF_GE**. None of these materials contain objections to or recommendations concerning ARB's proposed regulation, so response specific to these materials are not provided. ARB has separately responded to the comments that may rely on these materials.

[15] Duplicate of reference submitted under Comment #47 – Part 2 of 6.

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Comment letter code: 22-OP-ADF-GE

Commenter: Joshua Willter

Affiliation: Growth Energy

The following letter was submitted to the ADF Docket during the 45-day comment period.

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22_OP_ADF_GE Responses

129. Comment: **ADF 22-1**
The commenter included the following materials with its comment letter.

1. Argonne National Laboratory. (2014). Carbon Calculator for Land Use Change from Biofuels Production (CCLUB): User's Manual and Technical Documentation. Prepared by Dunn, J.B., Qin, Z., Mueller, S., Kwon, H.Y., Wander, M.M., & Wang, M. ANL/ESD/12-5 Rev. 2. September 2014. **(Ref07.pdf)**

2. Darlington, T., Kahlbaum, D., O'Connor, D., & Mueller, S. (2013). Land Use Change Greenhouse Gas Emissions of European Biofuel Policies Utilizing the Global Trade Analysis Project (GTAP) Model. August 30, 2013. **(Ref33.pdf)**

3. Eve, M., Pape, D., Flugge, M., Steele, R., Man, D., Riley-Gilbert, M., & Biggar, S. (Eds). (2014). *Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory*. Technical Bulletin Number 1939. Office of the Chief Economist, U.S. Department of Agriculture, Washington, DC. 606 pp. July 2014. **(4.pdf)**

4. Hamilton, S.K., Kurzman, A.L., Arango, C., Jin, L., & Robertson, G.P. (2007). "Evidence for Carbon Sequestration by Agricultural Liming." Global Biogeochemical Cycles, Volume 21, GB2021, doi: 10.1029/2006GB002738. June 5, 2007. **(5.pdf)**

5. Heath, L.S., Birdsey, R.A., Row, C., & Plantinga, A. (no date). 1996 Carbon Pools and Flux in U.S. Forest Products. In: Forest Ecosystems, Forest Management, and the Global Carbon Cycle (M.J. Apps and D.T. Price, eds). NATO ASI Series I: Global Environmental Changes, Volume 40, Springer-Verlag, 271-278 pp. **(Ref16.pdf)**

6. Intergovernmental Panel on Climate Change. (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Prepared by the National Greenhouse Gas Inventories Programme, Eggleston, H.S., Buendia, L., Miwa, K., Ngara, T., & Tanabe, K. (eds). Published: IGES, Japan. Retrieved from http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html **(V1_0_Cover.pdf; V1_1_Ch1_Introduction.pdf; V1_2_Ch2_DataCollection.pdf; V1_3_Ch3_Uncertainties.pdf; V1_4_Ch4_MethodChoice.pdf; V1_5_Ch5_Timeseries.pdf; V1_6_Ch6_QA_QC.pdf; V7_1_Ch7_Precursors_Indirect.pdf; V1_8_Ch8_Reporting_Guidance.pdf; V1_8x_Ch8_An1_Units_Index.pdf; V1_8x_Ch8_ReportingTables.pdf; V2_0_Cover.pdf;**

V2_2_Ch2_Stationary_Combustion.pdf;
V2_3_Ch3_Mobile_Combustion.pdf;
V2_4_Ch4_Fugitive_Emissions.pdf; V2_5_Ch5_CCS.pdf;
V2_6_Ch6_Reference_Approach.pdf; V2_x_An1_Worksheets.pdf;
V3_0_Cover.pdf; V3_1_Ch1_Introduction.pdf;
V3_2_Ch2_Mineral_Industry.pdf;
V3_3_Ch3_Chemical_Industry.pdf; V3_4_Ch4_Metal_Industry.pdf;
V3_5_Ch5_Non_Energy_Products.pdf;
V3_6_Ch6_Electronics_Industry.pdf;
V3_7_Ch7_ODS_Substitutes.pdf; V3_8_Ch8_Other_Product.pdf;
V3_x_An1_Worksheets.pdf; V3_x_An2_Potential_Emissions.pdf;
V3_x_An3_Improvements.pdf; V3_x_An4_IPPU_Glossary.pdf;
V4_00_Cover.pdf; V4_01_Ch1_Introduction.pdf;
V4_02_Ch2_Generic.pdf; V4_03_Ch3_Representation.pdf;
V4_04_Ch4_Forest_Land.pdf; V4_05_Ch5_Cropland.pdf;
V4_06_Ch6_Grassland.pdf; V4_07_Ch7_Wetlands.pdf;
V4_08_Ch8_Settlements.pdf; V4_09_Ch9_Other_Land.pdf;
V4_10_Ch10_Livestock.pdf; V4_11_Ch11_N2O&CO2.pdf;
V4_12_Ch12_HWP.pdf; V4_13_An1_Worksheets.pdf;
V4_13_An1_Worksheets.pdf; V4_14_An2_SumEqua.pdf;
V4_p_Ap1_Charcoal.pdf; V4_p_Ap2_WetlandsCO2.pdf;
V4_p_Ap3_WetlandsCH4.pdf; V5_0_Cover.pdf;
V5_1_Ch1_Introduction.pdf; V5_2_Ch2_Waste_Data.pdf;
V5_3_Ch3_SWDS.pdf; V5_4_Ch4_Bio_Treat.pdf;
V5_5_Ch5_IOB.pdf; V5_6_Ch6_Wastewater.pdf;
V5_x_An1_Worksheet.pdf)

7. Intergovernmental Panel on Climate Change. (2006). [spreadsheet]. IPCC Harvested Wood Products (HWP) Model. To be used in conjunction with Volume 4, Chapter 12, of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. **(V4_12_Ch12_HWP_Worksheet.xls in V4_12_Ch12_HWP_Worksheet.zip)**

8. Intergovernmental Panel on Climate Change. (2006). [spreadsheet]. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Implements Tier 1 method for estimating emissions of methane from solid waste disposal sites used in conjunction with Volume 5, Chapter 12, of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. **(IPCC_Waste_Model.xls)**

9. Keeney, R. & Hertel, T.W. (2008). Yield Response to Prices: Implications for Policy Modeling. Working Paper #08-13. Purdue University, West Lafayette, Indiana. August 2008. **(Ref11.pdf)**

10. Ray, D.K. & Foley, J.A. (2013). “Increasing Global Crop Harvest Frequency: Recent Trends and Future Directions.” Environmental

Research Letters 8, 044041, 10 pp., doi: 10.1088/1748-9326/8/4/044041. IOP Publishing. **(Ref09.pdf)**

11. U.S. Department of Agriculture. (2014). [map]. CropScape - Cropland Data Layer. http://nassgeodata.gmu.edu/CropScape/ **(10.pdf)**

12. U.S. Department of Agriculture. (2011). Conservation Reserve Program: Annual Summary and Enrollment Statistics, FY 2011. Prepared by Barbarika, A. **(Ref14A.pdf)**

13. U.S. Department of Agriculture. (2012). Conservation Reserve Program: Annual Summary and Enrollment Statistics, FY 2012. Prepared by Barbarika, A. **(Ref14B.pdf)**

14. U.S. Department of Agriculture. (2012). Conservation Reserve Program: Monthly Summary – December 2012. **(Ref14C.pdf)**

15. U.S. Department of Agriculture. (2012). Conservation Reserve Program: Status: End of December 2012. **(Ref14D.pdf)**

16. U.S. Department of Agriculture. (2013). Conservation Reserve Program: Monthly Summary – December 2013 (Revised). **(Ref14E.pdf)**

17. U.S. Department of Agriculture. (2013). Conservation Reserve Program: Status – End of December 2013. **(Ref14F.pdf)**

18. U.S. Department of Energy. (May 2000). Energy and Environmental Profile of the U.S. Chemical Industry. Prepared by Energetics Incorporated. Colombia, Maryland. **(11.pdf)**

19. U.S. Environmental Protection Agency. (2013). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011. U.S. Environmental Protection Agency, Washington, DC. EPA 430-R-13-001. April 12, 2013. **(3.pdf)**

20. Van Deusen, P.C. & Heath, L.S. (2010). “Weighted Analysis Methods for Mapped Plot Forest Inventory Data: Tables, Regressions, Maps and Graphs.” Forest Ecology and Management 260, 1607-1612. Journal homepage: www.elsevier.com/locate/foreco . August 5, 2010. **(Ref18.pdf)**

21. Wang, Michael Q., Jeongwoo Han, Zia Haq, Wallace E. Tyner, May Wu, and Amgad Elgowainy. (2011). "Energy and greenhouse gas emission effects of corn and cellulosic ethanol with technology improvements and land use changes." Biomass and Bioenergy 35, no. 5 (2011): 1885-1896. February 2, 2011. **(1.pdf)**

22. West, T.O. & McBride, A.C. (2005). “The Contribution of Agricultural Lime to Carbon Dioxide Emissions in the United States: Dissolution, Transport, and Net Emissions.” Agriculture, Ecosystems & Environment 108:145–154. **(6.pdf)**

Agency Response:

The comment letter duplicates pages 56 – 117 of Comment Letter **17_OP_ADF_GE**. See responses to **LCFS 46-79** through **LCFS 46-129**. The comment letter also contains 22 references that were cited in Comment Letter **22_OP_ADF_GE**. None of these materials contain objections to or recommendations concerning ARB’s proposed regulation, so response specific to these materials are not provided. ARB has separately responded to the comments that may rely on these materials.

Comment letter code: 23-OP-ADF-ALAC

Commenter: Will Barrett

Affiliation: American Lung Assoc., Calif.

The following letter was submitted to the ADF Docket during the 45-day comment period.

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23_OP_ADF
_ALAC

February 17, 2015

Chairman Mary Nichols
California Air Resources Board
1001 I Street
Sacramento, CA
95814

RE: Support for Alternative Diesel Fuel proposal

Dear Chairman Nichols:

On behalf of the undersigned organizations, we write in support of the California Air Resources Board's (CARB) proposed Alternative Diesel Fuel (ADF) regulation. We believe that the proposal successfully balances the need to encourage and incentivize alternatives to fossil fuels with the need to ensure that no additional harms are caused by these alternatives.

Because of the potential for biodiesel to increase smog-forming NO_x emissions under certain formulations, engine models and operating conditions, we support the ADF pathway set forward by CARB staff. While advanced engine technologies will mitigate NO_x issues with biodiesel, there is a need for near term mitigation to address biodiesel use in existing diesel engines. Fortunately, the proposed ADF regulation includes strategies to maximize the benefits of biodiesel, including offering exemptions for biodiesel fueling stations or fleets using technologies that control NO_x emissions. We strongly support this approach and encourage CARB to explore additional opportunities to capture NO_x-neutral and NO_x-reducing particulate and carbon pollution benefits. Even with this regulation, it will be important for CARB to continue monitoring biodiesel NO_x impacts to ensure control measures are working as intended to support clean air strategies.

Taken together with the Low Carbon Fuel Standard, the ADF will help to avoid nearly 100 deaths per year as cleaner alternatives to petroleum diesel are utilized in California. The air pollution and public health impacts of petroleum fuels are well-documented and must continue to be addressed through strong regulations that cut petroleum's impacts on lung health and our climate. We believe that the ADF is an important step in the process of curbing harmful pollutants and protecting the health of future generations of Californians.

Thank you for your work to continue to implement the Low Carbon Fuel Standard and to address the potential for NO_x impacts of alternatives to diesel fuels.

Sincerely,

Will Barrett
Senior Policy Analyst
American Lung Association in California

John Shears
Research Coordinator
The Center for Energy Efficiency and Renewable Technologies

Bill Magavern
Policy Director
Coalition for Clean Air

Tim O'Connor
Director, California Climate Initiative
Environmental Defense Fund

Simon Mui, Ph.D.
Director, California Vehicles and Fuels
Natural Resources Defense Council

23_OP_ADF_ALAC Responses

130. Comment: **ADF 23-1** The comment states that the ADF proposal successfully balances the need to encourage alternative fossil fuels with the need to protect the environment.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF proposal.

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Comment letter code: 24-OP-ADF-NOUS

Commenter: Dayne Delahoussaye

Affiliation: Neste Oil

The following letter was submitted to the ADF Docket during the 45-day comment period.

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NESTE OIL

24_OP_ADF
_NOUS

17 February 2015

Clerk of the Board, Air Resources Board
ATTN: Mary Nichols, Chairman
1001 I Street, PO Box 2815
Sacramento, California 95812

Re: Notice of Public Hearing to Consider the Proposed Regulation on the Commercialization of Alternative Diesel Fuels

Dear Chair Nichols and Air Resource Board Members:

Thank you for the opportunity to provide comments to the California Air Resources Board (CARB) regarding its re-adoption of the Low Carbon Fuel Standard (LCFS). Neste Oil US, Inc. respectfully presents the following comments for consideration.

As a part of the ARB's efforts in developing an alternative diesel fuel regulation, ARB staff considered renewable diesel. The ADF rule properly describes renewable diesel as a biomass-based diesel fuel made from biogenic feedstock sources. But, the fuel considered, tested, and described by ARB staff is more accurately described as renewable hydrocarbon diesel in that it consists solely of hydrocarbons and is indistinguishable from conventional diesel.

Unfortunately, the proposed definition is less accurate than the information presented in the Initial Statement of Reasons (ISOR). The proposed ADF regulation uses the term "non-ester renewable diesel". [Of note, staff in the Transportation Fuels Branch have proposed an alternative term and definition for the same product as a part of the Re-adoption of the Low Carbon Fuel Standard that uses the term "renewable diesel". At a minimum, we would encourage all programs under ARB to have unified definitions.] It is assumed that the origin of that term attempts to mirror the US EPA terminology. At that time that term was promulgated by US EPA, only the oxygenated biofuels (fatty acid methyl ester biodiesels or "FAME") were well known in the USA. There was no significant commercial experience with fungible renewable hydrocarbon diesel (RHD) in the USA.

The nomenclature "non-ester renewable diesel" would tend to exclude traditional biodiesel (fatty acid methyl-esters) but is not specific enough to exclude other oils that were not fungible hydrocarbons. It also attempts to define a fuel oil by what it is NOT rather than what it IS.

Confusion may exist in the market regarding fuels that are not fungible with conventional diesel and are not fully de-oxygenated but are nonetheless called "renewable diesel" and "non-ester renewable diesel". As such, that those terms are not ideal for use by the ARB in its regulations. As the ISOR describes ARB staff's evaluations and proposals regarding renewable diesel that is a hydrocarbon oil. The definition should reflect that fuel as accurately as possible.

We propose that the term "non-ester renewable diesel" be replaced with the term "renewable hydrocarbon diesel" (including references in the definitions of "Biodiesel Blend", "CARB Diesel", and Diesel Substitute".) We further propose that staff consult with the Transportation Fuels Branch and with

ADF 24-1

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1800 West Loop South, Suite 1700
Houston, Texas 77027
Tel. 713.407.4400 Telefax. 713.407.4480

NESTE OIL

the Department of Measurement Standards to align the nomenclature ("renewable hydrocarbon diesel") within the various regulations that touch and regulate this fuel.

ADF 24-1 cont.

In order to further align the ADF definition with those in the Proposed LCFS Regulations, we propose including language indicating that the fuel is intended for use in a compression ignition engine and that it must comply with ASTM D975-14a (2014). A uniform definition throughout the various ARB regulations will help reinforce a consistent nomenclature and description, accurately describe the fuel with adequate specificity, as well as avoid unnecessary confusion within the agency.

ADF 24-2

The proposed definition uses "derived from nonpetroleum renewable resources" as descriptive language. This is less useful for the regulations purposes in that is uses the word 'renewable' in the definition This is less useful for the regulations purposes in that is uses the word 'renewable' in the definition of 'renewable diesel' (potentially sloppy drafting), and attempts to define the fuel using a negative by what it is NOT rather than what it IS. A clearer definition would include the phrase "derived from biogenic sources" or "derived from biomass." The commonly understood, plain-meaning of both "biomass" and "biogenic sources" are clear and adequate and no new or clarifying explanation would be required in the regulations.

ADF 24-3

Accordingly, we propose the following definition (to be used in both ADF and LCFS regulation):

"Renewable Hydrocarbon Diesel" means:
a) a hydrocarbon oil meant for combustion in compression ignition engines;
b) derived from biomass;
c) not a mono-alkyl ester;
d) registered as a motor vehicle fuel or fuel additive under 40 CFR part 79; and
e) complies with ASTM D975-14a, (2014) *Specification for Diesel Fuel Oils*

ADF 24-4

Neste Oil looks forward to continued participation in the California fuel market and the success of the Alternative Diesel Fuel regulation. Please do not hesitate to contact me if at 713.407.4415 or Dayne.Delahoussaye@nesteoil.com if you have any questions regarding the foregoing.

Respectfully submitted,

NESTE OIL US, INC.



Dayne Delahoussaye

24_OP_ADF_NOUS Responses

131. Comment: **ADF 24-1**
The comment questions the term used to define renewable diesel.

Agency Response:
ARB staff has responded to the comment by modifying and clarifying the regulation as part of the 15-day changes. Staff replaced the term "*non-ester renewable*" with the term "*renewable hydrocarbon diesel*".

132. Comment: **ADF 24-2**
The comment states that ARB should try to use uniform definitions in its regulations with specific reference to the ADF and LCFS regulations.

Agency Response:
ARB staff agrees that it is important to have a uniform definition throughout the various ARB regulations to avoid unnecessary confusion. However, different regulations can have different purposes and as such it is sometimes necessary to have definitions which are specific to a regulation. Staff made every effort to make definitions consistent to avoid confusion as long as it did not compromise the intent of each specific regulation.

133. Comment: **ADF 24-3**
The comment suggests that if revising for consistency with the LCFS definition that the both the proposed LCFS definition be revised to removing the words nonpetroleum and renewable from the renewable hydrocarbon diesel definition.

Agency Response:
Staff believes the terms nonpetroleum and renewable are sufficiently descriptive to be included in the definition and as such did not make the suggested changes. The definition was clarified in the 15-day changes but did keep the referenced term, please see response **ADF 24-1**.

134. Comment: **ADF 24-4**
The comment suggests a revised definition for Renewable Hydrocarbon Diesel.

Agency Response:
Please see response **ADF 24-1**.The 15-day changes include a definition for Renewable Hydrocarbon Diesel similar to the definition suggested.

B. COMMENTS SUBMITTED AT THE FEBRUARY 19, 2015 HEARING

Three comment letters were received during at the February 19 board hearing. Each comment letter is reproduced below with responses following. Comment letter **03_B_ADF_GE** is 561 pages long and will be reproduced in discrete sections with the responses following each section for readability.

Comment letter code: 1-B-ADF-NSB

Commenter: Graham Noyes

Affiliation: North Star Biofuel

The following letter was submitted to the ADF Docket during the First Board Hearing.

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KEYES, FOX & WIEDMAN LLP

1_B_ADF
_NSB

February 19, 2015

Clerk of the Board
Air Resources Board
1001 I Street
Sacramento, CA 95814

RE: Comment of North Star Biofuels Regarding Alternative Diesel Fuel Regulation

Dear Chairwoman Mary Nichols and Members of the Board,

Thank you for the opportunity to provide comments regarding the proposed alternative diesel fuel regulation ("ADF"). This letter is submitted on behalf of my client, North Star Biofuels LLC ("North Star"). North Star is a leading California producer of high quality biodiesel with a production facility located in Watsonville, California. As is further described in this letter, North Star has developed and deployed a proprietary technology that enables its facility to produce biodiesel that demonstrates improved emissions performance as compared with conventional biodiesel. In particular, North Star's biodiesel has been rigorously tested at up to B20 blend levels and found to have equivalent nitrogen oxides ("NOx") emissions and substantially reduced particulate matter ("PM") emissions as compared to conventional CARB diesel. As a result, North Star is requesting that the Board revise the ADF regulatory language slightly to ensure that NOx solutions based upon production technology are clearly recognized and enabled under the ADF. ADF 1B-1

We have been engaged in discussions with Alexander Mitchell, Manager of the Emerging Technologies Section, and ARB staff regarding the issues raised in this letter. We have found these discussions to be very constructive. We recognize and appreciate the substantial efforts of the Board, ARB staff, Mr. Mitchell, and Executive Officer Richard Corey to receive input from the business community of low carbon fuel producers in California, and to craft the ADF regulation in a manner that enables California businesses to provide innovative commercial solutions that facilitate the achievement of California's air quality objectives.

980 Ninth Street, 16th Floor
Sacramento, CA 95814

North Star's Technology and CE- CERT NOx Testing Results

North Star is a joint venture between R Power Biofuels LLC and AB Bioenergy LLC (a subsidiary of Agri Beef Co., a vertically integrated meat company based in Boise, Idaho and producers of Snake River Farms and Double R Ranch high-quality meat products). North Star's Watsonville production facility has a nameplate capacity of 1,000 barrels (40,000 gallons) per day, making it one of the largest biodiesel production facilities in California. Over the past seven years, R Power and North Star have developed a biodiesel production technology that delivers commercial-scale biodiesel with exceptional purity, clarity, performance, and emissions reduction characteristics. The technology, for which the company was recently awarded a patent by the United States Patent and Trademark Office, is a fully automated, continuous flow biodiesel production technology.

Recognizing that NOx emissions are a crucial issue in California, North Star funded and undertook a testing program at UC Riverside's Center for Environmental Research and Technology ("CE-CERT") to demonstrate that the tailpipe emissions from blends of North Star biodiesel up to B20 are equivalent to CARB Diesel and that PM reductions are even greater than typical from biodiesel blends. Dr. Tom Durbin has been the principal investigator for North Star. Dr. Durbin has also served ARB as the primary resource in its technical review and analysis of biodiesel NOx performance that underpins the ADF. As a result, Dr. Durbin is very familiar with both the body of technical literature pertaining to biodiesel blends, and the protocols proposed in the ADF for certifying NOx neutrality.

Dr. Durbin's CE-CERT report on the testing conducted in December 2015 concluded that North Star's AFME-2 biodiesel blend showed NO_x neutrality with CARB Diesel for both the B10 and B20 blends, and PM emission reductions of 29% compared with CARB Diesel. Dr. Durbin has further advised that while the testing done for North Star was consistent with the ADF's protocols, the testing was not as comprehensive as the regulation requires in terms of repetition, sequencing of tests, and controls. Therefore, North Star is not asserting that the company has sufficiently fulfilled ARB requirements to receive certification for equivalency at this point. Instead, North Star is seeking a regulatory revision that will ensure that the ADF regulation clearly enables the certification of North Star's biodiesel blends once the company has completed fully compliant testing.

ADF 1B-2

980 Ninth Street, 16th Floor
Sacramento, CA 95814

ADF Regulatory Analysis as Applied to North Star

Under the ADF, biodiesel is treated as the first alternative diesel fuel. Biodiesel is effectively deemed to have completed stages one and two of the ADF requirements, and found to have adverse emissions impacts that cannot be eliminated by offsetting measures. As a result, in-use requirements for biodiesel are established pursuant to 17 CCR §2293.6 which states that, "ADFs which have been determined to have adverse emissions impacts after accounting for offsetting factors shall have a sub-section under this section listing appropriate in-use requirements including pollutant emission control trigger levels."

Section 2293.6(a) establishes in-use requirements for biodiesel phased in as follows:

1. Beginning January 1, 2016, reporting requirements are imposed.
2. Beginning January 1, 2018, pollutant control levels are imposed. These are variable based on whether the biodiesel is low saturation (unadditized cetane number below 56) or high saturation (above 56 cetane). Blends above specified levels are subject to in-use requirements.

Based on the results of the CE-CERT testing, North Star Biofuel has developed an innovative technological solution that enables the company to eliminate the NOx increases from biodiesel blend use while maintaining the particulate matter and other emissions benefits that biodiesel blends provided. It is our request that production technology solutions be explicitly integrated into the certification portion of the regulation, Appendix 1. This is easily achieved within the existing framework of the regulation.

ADF 1B-3

The following method would achieve this purpose (proposed new language in bold):

Appendix 1. In-use Requirements for Pollutant Emissions Control[1]
(…)
(a) Biodiesel:
(…)
(2) Certification of Alternative Diesel Fuels Resulting in Emissions Equivalence with Diesel
(…)
(B) The candidate fuel.
The candidate fuel to be used in the comparative testing described in (a)(2)(F) of

[1] The relevant section may be found in the rulemaking package, Appendix A, Proposed Regulation at page A-32/A-39.

this appendix shall be one of the following:

> 1. ADF formulation: The candidate fuel shall be the fuel blendstock or fuel blend that the applicant is attempting to certify. If the applicant is attempting to certify a fuel blend **such as a biodiesel with a heightened fuel specification or biodiesel produced utilizing a specified production technology,** that blend shall consist of the fuel blendstock blended to 20 percent with the Reference CARB Diesel.
> The applicant shall report all of the candidate fuel properties under (a)(3)(C) of this appendix for the candidate fuel.
> (…)

ADF 1B-3 cont.

We request that the Board include this language in the final version of the ADF regulation that it approves. Please advise if any further explanation would assist in your review of this request.

Sincerely,

Graham Noyes
Keyes, Fox & Wiedman LLP
Attorney for North Star Biofuels

Cc: Alexander Mitchell, Manager of Emerging Technologies Section
Michael Doyle, CEO, North Star Biofuels

1_B_ADF_NBB Responses

132. Comment: **ADF B1-1**
The comment requests that ARB revise the ADF regulatory language to ensure NOx solutions based upon production technology are recognized.

Agency Response:
The comment has been addressed in 15-day changes by clarifying that production processes may be considered under certification.

133. Comment: **ADF B1-2**
The comment requests a regulatory revision that ensures the ADF regulation clearly enables certification of biodiesel blends that are NOx neutral.

Agency Response:
ARB staff agrees with the comment and has modified the regulation accordingly.

134. Comment: **ADF B1-3**
The comment provides suggested language for a revision to the ADF proposal that will allow production technology solutions to be integrated into the certification of a fuel.

Agency Response:
ARB staff agrees with the comment and has modified the regulation accordingly.

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Comment letter code: 2-B-ADF-Gershen

Commenter: Joe Gershen

Affiliation: Individual

The following letter was submitted to the ADF Docket during the First Board Hearing.

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2_B_ADF
_Gershen

February 19, 2014

Mary D. Nichols, Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95812

Re: SUPPORT FOR LCFS READOPTION AND ADF REGULATION ADOPTION at February 19-20, California Air Resources Board Hearing – Items: 15-2-3 & 15-2-4

Dear Chair Nichols,

I am very supportive of both the re-adoption of the Low Carbon Fuel Standard ("LCFS") and the adoption of the Alternative Diesel Fuel ("ADF") regulation. I would like to thank ARB leadership and staff for all their hard work on these issues, which are vitally important to Californians. I would also like to commend you on implementing a program that has inspired other carbon reduction plans on the west coast and around the country and North America.

Driven by my intense concern over global climate change, I've spent nearly 15 years committed to education, fleet transition and implementation of biodiesel in California, and have watched it grow from a fledgling idea of a few pioneering environmentalists, scientists and engineers into a robust and growing industry that has created hundreds of high paying green California jobs in some of the most disadvantaged communities around the state.

Today the California biodiesel industry is capable of reducing over 610,000 metric tons of carbon emissions from our atmosphere, which is equivalent to removing almost 140,000 cars from California roads. But these metrics took on important and measurable meaning when ARB put them into the context of the Low Carbon Fuel Standard. This groundbreaking, critical policy demonstrates California's commitment to environmental and energy sustainability while simultaneously sending a strong and stable signal to the business community that will encourage investment and innovation, which will, in turn, help to further the state's carbon reduction goals.

The development of the ADF regulation has been a challenging process but ARB has been very mindful of all stakeholder interests and I am very appreciative of that effort. The California biodiesel industry is made up of independent producers, marketers, feedstock suppliers and other interested companies of all sizes. The challenge has been to be inclusive and ARB staff has been attentive to our needs and demonstrated their willingness to work with our industry to help develop a variety of compliance options.

I am confident that working together with ARB, the California biodiesel industry can build on its success. Last year biodiesel was responsible for generating 16% of all LCFS credits while contributing approximately $350 million in economic activity to California's economy. We look forward to doing even more to reduce carbon, lower emissions, displace petroleum and create good, high paying jobs in disadvantaged California communities.

Respectfully submitted,

Joe Gershen
Biodiesel industry veteran
CBA Vice-Chair

2_B_ADF_Gershen Responses

135. Comment: **ADF B2-1**
The comment letter supports the adoption of the ADF regulation.

Agency Response:
ARB staff appreciates the supportive comments from an industry veteran.

Comment letter code: 3-B-ADF-GE

Commenter: Joshua Willter

Affiliation: Growth Energy

The following letter was submitted to the ADF Docket during the First Board Hearning.

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12_B_LCFS
_GE

3_B_ADF
_GE

STATE OF CALIFORNIA

AIR RESOURCES BOARD

PROPOSED AMENDMENTS TO THE CALIFORNIA LOW CARBON FUELS STANDARD REGULATION AND THE PROPOSED REGULATION ON THE COMMERCIALIZATION OF ALTERNATIVE DIESEL FUELS

GROWTH ENERGY'S RESPONSE
TO THE NOTICES OF PUBLIC HEARINGS DATED DECEMBER 16, 2014
2015 CAL. REG. NOTICE REG. 13, 45 (JANUARY 2, 2015)

ADDITIONAL EXHIBITS TO COMMENTS FILED FEBRUARY 17, 2015

FEBRUARY 19, 2015

Exhibit Cover Sheet

growth energy
America's Ethanol Producers

777 North Capitol Street, NE, Suite 805, Washington, D.C. 20002
PHONE 202.545.4000 FAX 202.545.4001 GrowthEnergy.org

May 10, 2010

Mr. James N. Goldstene
Executive Officer, California Air Resources Board
1001 I Street, 23rd Floor
Sacramento, California 95812

By Hand and Electronic Mail

Re: Petition to Amend the Low-Carbon Fuel Standard Regulation Pursuant to Cal. Gov't Code § 11340.6

Dear Mr. Goldstene:

On behalf of Growth Energy, an association of the nation's leading ethanol manufacturers and other companies who serve the nation's need for alternative fuels, I respectfully petition for amendments to the California low-carbon fuel standard ("LCFS") regulation published in title 17 of the *California Code of Regulations* at 17 C.C.R. §§ 9548-95490. That regulation was approved by the California Air Resources Board ("CARB" or "the Board") in April 2009, and you took final action with respect to the relevant provisions of the LCFS regulation in November 2009. This petition is submitted pursuant to section 11340.6 of the California Government Code. It is based upon data and analysis that has become available to Growth Energy within the last two weeks.[1]

The specific amendments to the LCFS regulation proposed by Growth Energy are as follows:

1. An amendment to the LCFS regulation that would take effect no later than December 31, 2010, that would eliminate the "Land Use or Other Indirect Effect" carbon intensity values assigned to the corn ethanol pathways in Table 6 in section 95486 ("Table 6") for corn ethanol used to comply with the LCFS regulation in 2011 and 2012. LCFS B12-1

[1] The relevant new developments are also discussed in a letter to ARB from the Renewable Fuels Association ("RFA") dated April 28, 2010, which, while not formally requesting action under the Government Code, also recommends an immediate change in the LCFS regulation. The RFA letter is included as an attachment to this petition.

2. As an alternative to the amendment presented above in paragraph 1, an amendment to the LCFS regulation that would take effect no later than December 31, 2010, and that would replace the 30 gram of carbon dioxide-equivalent emissions per megajoule ("g/mj") value in Table 6 for corn ethanol pathways with 15.1 or 13.9 g/mj, for corn ethanol used to comply with the LCFS regulation in 2011 and 2012. LCFS B12-2

3. If the amendment presented in paragraph 1 is not adopted, then in addition to the amendment presented in paragraph 2, an amendment to the LCFS regulation that would take effect no later than September 30, 2010, and that would require the Executive Officer to take final action on a Method 2A or Method 2B submittal under section 95486 within 90 days of his receipt of a complete submittal pursuant to Method 2A or Method 2B. LCFS B12-3

The change in paragraph 1 above would be effected by replacing "30" in the indirect emissions values for corn ethanol in Table 6 with "0." Changes in regulatory text sought in paragraphs 2 and 3 of the petition are shown in Exhibit 1. The balance of this letter and the attached exhibits provide the rest of the information required by section 11340.6 of the Government Code. LCFS B12-4

I. Authority to Amend the LCFS Regulation and Requirements of the Government Code

Sections 39600-39601 of the Health & Safety Code empower the Board to adopt regulations in accordance with the California Administrative Procedure Act ("the APA"). The power to adopt regulations brings with it the power to amend regulations. Except when the right to do so is otherwise restricted, section 11340.6 of the Government Code permits any interested person to seek amendment to rules adopted by the Board. There is no statutory impediment to consideration of this petition on its merits. A response is therefore required in the manner described in your recent response to another petition under section 11340.6 of the Government Code, in which you stated as follows:

> Under Government Code section 11340.7, the State agency within 30 days may grant or deny the petition in part, and may grant any other relief or take any other action as it may determine to be warranted by the petition. It must also indicate why the agency has reached its decision in writing and if it grants the petition, it must schedule the matter for public hearing in accordance with the notice and hearing requirements of the APA.

Letter to M. Steele from J. Goldstene, Feb. 11, 2010 at 1 n.1 (*see* Exhibit 2). If you determine that you lack authority under sections 39515 and 39516 to consider and to grant any aspect of this petition, Growth Energy requests that (i) you refer this petition to the Board, and (ii) the Board grant this petition. LCFS B12-5

II. Grounds for Amendment of the LCFS Regulation.

The Board adopted the LCFS regulation as an early-action measure to implement the Global Warming Solutions Act of 2006, codified at sections 38500-38599 of the Health & Safety Code (the "2006 Act"). The Legislature directed ARB to use the "best available economic and scientific information" when adopting regulations to implement the 2006 Act. Health & Safety Code § 38652 (e).

During the LCFS rulemaking, ARB selected models developed by the Global Trade Analysis Project ("GTAP") to estimate the indirect emissions impact of the use of corn ethanol to comply with the LCFS regulation. As you explained in announcing the use of GTAP at the start of the LCFS rulemaking:

> To assess the emissions from land use changes, staff used the Global Trade Analysis Project (GTAP) [model] to estimate [greenhouse gas, or "GHG"] emissions impact. ... In general, the [GTAP] model evaluates the worldwide land use conversion associated with the production of crops for fuel production. Different types of land use have different rates of storing carbon. In general, multiplying the changes in land use times an emission factor per land conversion type results in an estimate of the GHG emissions impacts of land conversions.

Notice of Public Hearing to Consider Adoption of a Proposed Regulation to Implement the Low Carbon Fuel Standard (dated Feb. 24, 2009) at 8. The suite of the GTAP models used in last year's LCFS regulation is specified in the regulation at 17 C.C.R. §95481(a)(20.5), and is called in the regulation the "February 2009" version of GTAP.

LCFS B12-6

The GTAP modeling system was developed by the faculty and staff of the Department of Agricultural Economics at Purdue University. It should be noted in this regard that at least one GTAP expert at Purdue (Dr. Thomas Hertel) advised the Board at the inception of the regulatory process that the use of GTAP to select single-point carbon intensity values might be less defensible than other uses of the GTAP system and could be considered arbitrary. Last month researchers at Purdue led by Professor Wallace E. Tyner reported the development of a new and, in their opinion, improved version of the GTAP modeling system, called GTAP-BIO-ADV. Their research was partially funded by the Argonne National Laboratory. A final report summarizing the changes made in the GTAP modeling system has been prepared and is attached to this petition as Exhibit 3. Consistent with Dr. Hertel's advice during the rulemaking process, the new GTAP report presents a range of indirect land-use emissions values for corn ethanol, and invites the reader to evaluate the range of outputs and the assumptions that produce the different outputs.[2]

As indicated in the new report from the GTAP researchers at Purdue, the indirect emissions impact that Table 6 attributes to corn ethanol (which is based on the February 2009 version of GTAP) is significantly overstated, based on the results of GTAP-BIO-ADV. Table 6 assigns an indirect carbon intensity value to corn ethanol of **30 g/mj**. Based on certain assumptions about growth in yield and population, the average indirect land-use emissions that can properly be attributed to corn ethanol using the updated GTAP modeling system is **13.9 g/mj**, or less than half the level used in Table 6, measured in g/mj of carbon intensity. The marginal carbon intensity value that the new analysis based on GTAP-BIO-ADV would attribute to corn ethanol's indirect effects under those same assumptions about yield and

LCFS B12-7

[2] It should be noted that Growth Energy does not agree with some of the fundamental assumptions made in indirect land-use change ("ILUC") theory applied in the LCFS rulemaking, and that Growth Energy believes that the final LCFS regulation failed to comply with the 2006 Act and other legal requirements, even before publication of the new work on GTAP discussed in this petition.

LCFS B12-6 cont.

population growth is **15.1 g/mj.** The Board should not overlook this important change in the results that are produced by the GTAP modeling system using updated data, which was not available to the Board when it approved the LCFS regulation, nor available to the public during the post-hearing review process last summer and fall.

LCFS B12-7 cont.

Growth Energy does not believe that the economic and scientific bases for attribution of indirect emissions impacts to corn ethanol usage are adequate, as explained in comments submitted to ARB last year. Putting that disagreement with the Board's overall approach to the side, however, it should be clear that ARB must reconsider Table 6 before the LCFS regulation takes full effect at the start of 2011. Discussing the carbon intensity values developed last year, one consultant for ARB testified as follows at the April 2009 Board hearing:

> [I]f we make a mistake in one direction in estimating these numbers, we'll use too much of a biofuel that's actually higher carbon [than] we thought and will therefore increase global warming. And if we use numbers that are too low, then we'll use too little of a biofuel that's lower carbon than we thought and will therefore increase global warming.

LCFS B12-8

See April 2009 Hearing Transcript, *available at* http://www.arb.ca.gov/board/mt/2009/mt042309.pdf, at 73-74. As the same witness pointed out, "the cost to the world of being wrong in both directions is fairly symmetrical," and "there's no obvious conservative direction" to take in order to minimize the risks and costs of error. *Id.* at 74.

There is debate today about how to conduct a full lifecycle emissions analysis of transportation fuels. At this point, however, it should be clear that the GTAP modeling framework as adapted to a lifecycle analysis for corn ethanol has changed significantly since 2009. Moreover, the results produced by the GTAP systems are highly dependant on some assumptions that (in the latest report from Purdue) are not fully documented or explained. For example, it is far from clear whether what the new report calls the "yield effect" on food consumption is consistent with historical data. The selection of a population growth rate in the new iteration of the model is also not fully explained, and the new model appears to continue the assumption in the old model that forest land is converted in roughly the same proportion to all other land types. The new model is therefore likely to overstate the impact of corn ethanol usage on greenhouse gas emissions, accepting all other assumptions made in the ILUC theory. The new GTAP system may be an improvement over the February 2009 version, but the risk of error that punishes corn ethanol without a proper scientific basis remains great.

LCFS B12-9

Given the risk of error, Growth Energy believes that the best course would be to eliminate any indirect emissions penalty for ethanol, and perhaps for all other biofuels, for at least the first two years of the LCFS compliance period (2011 and 2012), so that the science can catch up with regulatory process. Such a deferral of indirect emissions assessments will give the Board's external expert working groups time to formulate and present recommendations for full lifecycle analysis to the Board. A decision to defer ILUC-based emissions penalties in Table 6 for a full two years should be made now, so that the regulated parties can develop initial compliance plans with the LCFS regulation that are not based on clearly mistaken ILUC-based penalties. Assuming that the expert working groups can report to the Board by the end of the current year and recommend appropriate reforms in lifecycle emissions assessments at

LCFS B12-10

that time, and that the Board can act on those recommendations in early 2011, then revised carbon intensity values could be included in Table 6 in early 2011 to take effect in 2013.

LCFS B12-10 cont.

Even if ARB maintains the view (not shared by Growth Energy) that there is surely some indirect emissions impact from corn ethanol use, and that the indirect emissions value must be "greater than zero," there should be no disagreement that the February 2009 verison of the GTAP modeling system on which the LCFS regulation is currently based is now obsolete. When the GTAP modeling system is updated with what the new Purdue report calls "model improvements" and with a 2006 data base, there is a substantial reduction in the carbon intensity values that the Purdue team believes can credibly be assigned to corn ethanol. (*See, e.g.*, Exhibit 3, Table 20 at p. 46.) The use of a 2006 data base seems itself to be questionable, but the availability of that data set certainly shows that the older data set used in the February 2009 version of the GTAP modeling system is no longer the "best available economic and scientific information." Health & Safety Code § 38652 (e). Surely, those who believe that some "non-zero" value needs to be assigned to indirect emissions from the use of biofuels would agree that the 30 g/mj value in Table 6 is not the correct or most reliable "non-zero" value, and must be changed in order to avoid a serious mistake.

LCFS B12-11

Based on the new work at Purdue (but without agreeing with the premise that corn ethanol must be assigned some indirect land-use change emissions impact), if the Board believes that a "non-zero" value for indirect emissions must remain in Table 6, Growth Energy believes that consistency with the "best available" science requirement of the 2006 Act mandates the replacement of the 30 g/mj value with either 13.9 or 15.1 g/mj, depending on whether ARB decides to use average or marginal emissions values. Such a change should be made now, with the expectation that the expert working group and the Board will be able to revisit the issue in time to make any necessary further changes for biofuels usage after 2012. If such a change is not made now, the LCFS regulation will take full effect in a few months' time using carbon intensity values that are simply no longer credible.[3]

LCFS B12-12

In the event that ARB decides not to establish a two-year moratorium on the use of indirect emissions impacts for corn ethanol, Growth Energy requests two further regulatory changes in addition to the reduction in the indirect emissions values assigned to corn ethanol in 2011 and 2012. First, given the importance of prompt action on revisions to the carbon intensity values assigned to alternative fuels, Growth Energy also requests that section 95486 be revised to include a 90-day deadline for action on Method 2A and Method 2B applications. Second, in light of the rapid pace of developments in the GTAP modeling structure, Growth Energy believes it would be appropriate to amend the LCFS regulation to make it clear that the Executive Officer should permit the use of updated versions of the GTAP models in the Method 2A and Method 2B procedures for determining carbon intensity.

LCFS B12-13

LCFS B12-14

[3] During the rulemaking process that Growth Energy seeks, it is possible that other interested parties could come forward with data and analysis to support changes in the indirect land-use change values assigned to ethanol produced from sugar cane. To avoid proliferation of proceedings, Growth Energy recommends that any such changes sought in the indirect emissions values assigned to ethanol produced from sugar cane be presented without delay pursuant to Government Code § 11340.6. Growth Energy would vigorously oppose any action with respect to such a petition concerning sugar cane ethanol that might result in a delay in consideration of amendments sought in this petition.

LCFS B12-12 cont.

The dates specified for final action to amend the current regulation presented on pages one and two of this letter (by December 31, 2010, for the amendments to Table 6, and by September 20, 2010 for the Method 2A/2B amendments) are critical to the objectives of this petition. Any delay from those dates will therefore mean effective denial of the petition. ARB should proceed with the publication of a notice for a public hearing to consider the changes requested here as soon as possible, and certainly no later than the 30-day period allowed by the Government Code for action on petitions of this type.

LCFS B12-15

* * * *

Thank you for considering this petition. Please contact me at 605-965-2375 if you have any questions, or if further steps are required for consideration of this petition by you or by the Board.

Sincerely,

David Bearden

David Bearden
General Counsel

cc: Ellen Peter, Esquire

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3_B_ADF_GE Responses (Page 1 – 8)

136. Comment: **LCFS B12-1 through LCFS B12-15**

Agency Response:
These pages are proposed regulatory changes associated with comment **LCFS B12-4**. As such, see the response to **LCFS B12-4**, in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **12_B_LCFS_GE**.

Exhibit 1

Table 6. Carbon Intensity Lookup Table for Gasoline and Fuels that Substitute for Gasoline.

Fuel	Pathway Description	Carbon Intensity Values (gCO2e/MJ)		
		Direct Emissions	Land Use or Other Indirect Effect	Total
Gasoline	CARBOB – based on the average crude oil delivered to California refineries and average California refinery efficiencies	95.86	0	95.86
Ethanol from Corn	Midwest average; 80% Dry Mill; 20% Wet Mill; Dry DGS	69.40	~~30~~ 15.1 or 13.9	~~99.40~~ 84.5 or 83.3
	California average; 80% Midwest Average; 20% California; Dry Mill; Wet DGS; NG	65.66	~~30~~ 15.1 or 13.9	~~95.66~~ 80.76 or 79.56
	California; Dry Mill; Wet DGS; NG	50.70	~~30~~ 15.1 or 13.9	~~80.70~~ 65.8 or 64.6
	Midwest; Dry Mill; Dry DGS, NG	68.40	~~30~~ 15.1 or 13.9	~~98.40~~ 83.5 or 82.3
	Midwest; Wet Mill, 60% NG, 40% coal	75.10	~~30~~ 15.1 or 13.9	~~105.10~~ 90.2 or 89.0
	Midwest; Wet Mill, 100% NG	64.52	~~30~~ 15.1 or 13.9	~~94.52~~ 79.62 or 78.42
	Midwest; Wet Mill, 100% coal	90.99	~~30~~ 15.1 or 13.9	~~120.99~~ 106.09 or 104.89
	Midwest; Dry Mill; Wet, DGS	60.10	~~30~~ 15.1 or 13.9	~~90.10~~ 75.2 or 74.0

	California; Dry Mill; Dry DGS, NG	58.90	~~30~~ 15.1 or 13.9	~~88.90~~ 74.0 or 72.8
	Midwest; Dry Mill; Dry DGS; 80% NG; 20% Biomass	63.60	~~30~~ 15.1 or 13.9	~~93.60~~ 78.7 or 77.5
	Midwest; Dry Mill; Wet DGS; 80% NG; 20% Biomass	56.80	~~30~~ 15.1 or 13.9	~~86.80~~ 71.9 or 70.7
	California; Dry Mill; Dry DGS; 80% NG; 20% Biomass	54.20	~~30~~ 15.1 or 13.9	~~84.20~~ 69.3 or 68.1
	California; Dry Mill; Wet DGS; 80% NG; 20% Biomass	47.44	~~30~~ 15.1 or 13.9	~~77.44~~ 62.54 or 61.34
Ethanol from Sugarcane	Brazilian sugarcane using average production processes	27.40	46	73.40
	Brazilian sugarcane with average production process,mechanized harvesting and electricity co-product credit	12.40	46	58.40
	Brazilian sugarcane with average production processand electricity co-product credit	20.40	46	66.40
Compressed Natural Gas	California NG via pipeline; compressed in CA	67.70	0	67.70
	North American NG delivered via pipeline; compressedin CA	68.00	0	68.00
	Landfill gas (bio-methane) cleaned up to pipeline quality NG; compressed in CA	11.26	0	11.26
	Dairy Digester Biogas to CNG	13.45	0	13.45
Liquefied Natural Gas	North American NG delivered via pipeline; liquefied in CA using liquefaction with 80% efficiency	83.13	0	83.13
	North American NG delivered via pipeline; liquefied inCA using liquefaction with 90% efficiency	72.38	0	72.38

	Overseas-sourced LNG delivered as LNG to Baja;re-gasified then re-liquefied in CA using liquefactionwith 80% efficiency	93.37	0	93.37
	Overseas-sourced LNG delivered as LNG to CA;re-gasified then re-liquefied in CA using liquefaction with 90% efficiency	82.62	0	82.62
	Overseas-sourced LNG delivered as LNG to CA;no re-gasification or re-liquefaction in CA	77.50	0	77.50
	Landfill Gas (bio-methane) to LNG liquefied in CA using liquefaction with 80% efficiency	26.31	0	26.31
	Landfill Gas (bio-methane) to LNG liquefied in CA using liquefaction with 90% efficiency	15.56	0	15.56
	Dairy Digester Biogas to LNG liquefied in CA using liquefaction with 80% efficiency	28.53	0	28.53
	Dairy Digester Biogas to LNG liquefied in CA usingliquefaction with 90% efficiency	17.78	0	17.78
Electricity	California average electricity mix	124.10	0	124.10
	California marginal electricity mix of natural gas andrenewable energy sources	104.71	0	104.71
Hydrogen	Compressed H2 from central reforming of NG (includes liquefaction and re-gasification steps)	142.20	0	142.20
	Liquid H2 from central reforming of NG	133.00	0	133.00
	Compressed H2 from central reforming of NG (no liquefaction and re-gasification steps)	98.80	0	98.80
	Compressed H2 from on-site reforming of NG	98.30	0	98.30
	Compressed H2 from on-site reforming with renewable feedstocks	76.10	0	76.10

(c) *Method 2A – Customized Lookup Table Values (Modified Method 1).*

Under Method 2A, the regulated party may propose, for the Executive Officer's written approval pursuant to section 95486(f), modifications to the GTAP Model or to one or more inputs to the CA-GREET model used to generate the carbon intensity values in the Method 1 Lookup Table.

For any of its transportation fuels subject to the LCFS regulation, a regulated party may propose the use of Method 2A to determine the fuel's carbon intensity, as provided in this section 95486(c). For each fuel subject to a proposed Method 2A, the regulated party must obtain written approval from the Executive Officer for its proposed Method 2A before the regulated party may use Method 2A for determining the carbon intensity of the fuel. The Executive Officer's written approval may include more than one of a regulated party's fuels under Method 2A.

The Executive Officer may not approve a proposed Method 2A unless the regulated party and its proposed Method 2A meet the scientific defensibility, "5-10" substantiality, and data submittal requirements specified in section 95486(e)(1) through (3) and the following requirements:

(1) The proposed modified GTAP Model or CA-GREET inputs must accurately reflect the conditions specific to the regulated party's production and distribution process;

(2) The proposed Method 2A uses only the inputs that are already incorporated in CA-GREET and does not add any new inputs (e.g., refinery efficiency); and

(3) In lieu of use of the GTAP Model or a modified GTAP Model, the ~~The~~ regulated party ~~must~~ may request the Executive Officer to conduct an analysis or modeling to determine the new pathway's impact on total carbon intensity due to indirect effects, including land-use changes, as the Executive Officer deems appropriate. ~~The Executive Officer will use the GTAP Model (February 2009), which is incorporated by reference, or other model determined by the Executive Officer to be at least equivalent to the GTAP Model (February 2009).~~

(d) *Method 2B – New Pathway Generated by California-Modified GREET (v.1.8b).* Under Method 2B, the regulated party proposes for the Executive Officer's written approval the generation of a new pathway using the CA-GREET model as provided for in this provision and the GTAP Model or a modified GTAP model. The Executive Officer's approval is subject to the requirements as specified in section 95486(f) and the following requirements:

(1) For purposes of this provision, "new pathway" means the proposed full fuel-cycle (well-to-wheel) pathway is not already in the ARB Lookup

Table specified in section 95486(b)(1), as determined by the Executive Officer;

(2) The regulated party must demonstrate to the Executive Officer's satisfaction that the CA-GREET can be modified successfully to generate the proposed new pathway. If the Executive Officer determines that the CA-GREET model cannot successfully generate the proposed new pathway, the proponent-regulated party must use either Method 1 or Method 2A to determine its fuel's carbon intensity;

(3) The regulated party must identify all modified parameters for use in the CA-GREET for generating the new pathway;

(4) The CA-GREET inputs used to generate the new pathway must accurately reflect the conditions specific to the regulated party's production and marketing process; and

(5) In lieu of use of the GTAP Model or a modified GTAP Model, the ~~The~~ regulated party ~~must~~ may request the Executive Officer to conduct an analysis or modeling to determine the new pathway's impact on total carbon intensity due to indirect effects, including land-use changes, as the Executive Officer deems appropriate. ~~The Executive Officer will use the GTAP Model (February 2009), which is incorporated by reference, or other model determined by the Executive Officer to be at least equivalent to the GTAP Model (February 2009).~~

(e) *Scientific Defensibility, Burden of Proof, Substantiality, and Data Submittal Requirements and Procedure for Approval of Method 2A or 2B.* For a proposed Method 2A or 2B to be approved by the Executive Officer, the regulated party must demonstrate that the method is both scientifically defensible and, for Method 2A, meets the substantiality requirement, as specified below:

(1) *Scientific Defensibility and Burden of Proof.* This requirement applies to both Method 2A and 2B. A regulated party that proposes to use Method 2A or 2B bears the sole burden of demonstrating to the Executive Officer's satisfaction, that the proposed method is scientifically defensible.

(A) For purposes of this regulation, "scientifically defensible" means the method has been demonstrated to the Executive Officer as being at least as valid and robust as Method 1 for calculating the fuel's carbon intensity.

(B) Proof that a proposed method is scientifically defensible may rely on, but is not limited to, publication of the proposed Method 2A or 2B in a major, well-established and peer-reviewed scientific journal (e.g., Science, Nature, Journal of the Air and Waste Management Association, Proceedings of the National Academies of Science).

(2) *"5-10" Substantiality Requirement.* This requirement applies only to a proposed use of Method 2A, as provided in section 95486(c). For each of its transportation fuels for which a regulated party is proposing to use Method 2A, the regulated party must demonstrate, to the Executive Officer's satisfaction, that the proposed Method 2A meets both of the following substantiality requirements:

(A) The source-to-tank carbon intensity for the fuel under the proposed Method 2A is at least 5.00 grams CO2-eq/MJ less than the source to-tank carbon intensity for the fuel as calculated under Method 1. "Source-to-tank" means all the steps involved in the growing/extraction, production and transport of the fuel to California, but it does not include the carbon intensity due to the vehicle's use of the fuel; "source-to-tank" may also be referred to as "well-to-tank" or "field-to-tank."

(B) The regulated party can and is expected to provide in California more than 10 million gasoline gallon equivalents per year (1,156 MJ) of the regulated fuel. This requirement applies to a transportation fuel only if the total amount of the fuel sold in California from all providers of that fuel exceeds 10 million gasoline gallon equivalents per year.

(3) *Data Submittal.* This requirement applies to both Method 2A and 2B. A regulated party proposing Method 2A or 2B for a fuel's carbon intensity value must meet all the following requirements:

(A) Submit to the Executive Officer all supporting data, calculations, and other documentation, including but not limited to, flow diagrams, flow rates, CA-GREET calculations, equipment description, maps, and other information that the Executive Officer determines is necessary to verify the proposed fuel pathway and how the carbon intensity value proposed for that pathway was derived;

(B) All relevant data, calculations, and other documentation in (A) above must be submitted electronically, such as via email or an online web-based interface, whenever possible;

(C) The regulated party must specifically identify all information submitted pursuant to this provision that is a trade secret; "trade secret" has the same meaning as defined in Government Code section 6254.7; and

(D) The regulated party must not convert spreadsheets in CA-GREET containing formulas into other file formats.

~~(D)~~ (f) The Executive Officer shall take final action a request for modification of a fuel's carbon intensity value using Method 2A or Method 2B within 90 days of a complete submittal of such a request. The Executive Officer shall notify a party making a submittal using Method 2A or Method 2B within 15 days of receipt of such a submittal whether he has found the submittal to be complete.

3_B_ADF_GE Responses (Page 9 – 16)

137. Comment: **Exhibit 1**

Agency Response:
These pages are proposed regulatory changes associated with comment **LCFS B12-4**. As such, see the response to **LCFS B12-4**, in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **12_B_LCFS_GE**.

Exhibit 2

Air Resources Board

Mary D. Nichols, Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Linda S. Adams
Secretary for
Environmental Protection

Arnold Schwarzenegger
Governor

(Via email and U.S. Mail)

February 11, 2010

Mr. Michael J. Steel, Esq.
Morrison Foerster
425 Market Street
San Francisco, California, 94105-2482
msteel@mofo.com

Re: Response to January 11, 2010, Petition Filed by Associated General Contractors of America

Dear Mr. Steel:

I am writing in response to the petition filed pursuant to the Administrative Procedure Act (APA), Government Code section 11340.6, by the Associated General Contractors of America (AGC or petitioner) dated January 11, 2010.[1] The petition requests that the Air Resources Board (ARB or Board) adopt an emergency amendment to delay the fleet average target dates of the In-Use Off-Road Diesel-Fueled Fleets Regulation (regulation)[2] for two years. The petition also requests that ARB ask the United States Environmental Protection Agency (U.S. EPA) to postpone consideration of California's request for authorization of the regulation that ARB submitted pursuant to section 209(e)(2) of the federal Clean Air Act (CAA) until such time that ARB has resolved the issues underlying the petition.

After careful consideration of all of the facts associated with the petitioner's request, pursuant to Government Code section 11340.7(b), I am granting the following relief and finding that the following actions are warranted:

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[1] The petition is available from ARB upon request. Under the APA, any interested person may petition a State agency requesting the adoption, amendment, or repeal of a regulation as provided in Government Code section 11340.6. The petition must clearly and concisely state the substance or nature of the regulation, the requested amendment or repeal, the reason for the request, and the reference to the authority of the State agency to take the action requested. Under Government Code section 11340.7, the State agency within 30 days may grant or deny the petition in part, and may grant any other relief or take any other action as it may determine to be warranted by the petition. It must also indicate why the agency has reached its decision in writing and if it grants the petition, it must schedule the matter for public hearing in accordance with the notice and hearing requirements of the APA.

[2] Title 13, California Code of Regulations, sections 2449 through 2449.3.

(1) ARB will issue an advisory notifying all stakeholders subject to the regulation that ARB will take no enforcement action regarding compliance with the regulation's emission standards or other emission related requirements before ARB receives authorization from U.S. EPA; and

(2) a hearing will be held in Sacramento on March 11, 2010, before the Executive Officer to take testimony and other relevant information on the need for further amendments to the regulation to address the economic recession confronting the State and the adverse impacts that the recession has caused to the construction and other industries that operate off-road vehicles. As the Board has already directed staff to provide an update on the regulation at its April 2010 meeting, any information and testimony collected at this hearing shall be compiled and included as part of that update.

This relief, coupled with statutory and regulatory relief already provided by Assembly Bill 8 2X (AB 8 2X or bill), will ensure no stakeholders will be in violation with the regulation's March 1, 2010 emission standards or other emission related requirements. Therefore, I have concluded that an emergency does not exist. I am also taking no action on the petitioner's request that ARB request U.S. EPA to delay issuance of the authorization, because the request is outside the scope of the APA petition process.

Summary of January 11, 2010 Petition

The petitioner's request that ARB delay implementation of the regulation can be summarized as follows: since the Board's approval and adoption of the regulation in 2007-2008, changed circumstances in the economy and its impact on construction activity in California have affected the financial ability of construction fleets to comply with the regulation's requirements while concurrently resulting in fewer emissions from construction vehicles. In claiming that a two-year moratorium in implementing the initial compliance requirements is urgently necessary, the petition argues that, without such immediate relief, California construction contractors will suffer immediate and irreparable harm because the regulation as it currently exists will force fleets to either downsize or have to purchase and install expensive and unreliable emission control devices or repower their equipment in order to meet the 2010 and 2011 fleet average requirements.[3] In making this claim, AGC asserts that the relief provided by AB 8 2X signed by the Governor on February 20, 2009, provides insufficient relief with "some relief to some contractors, but not to others, and certainly not to all [a]nd even those relieved of the initial burdens will find that that [sic] their relief is fleeting. . . ."[4]

[3] Petition at p. 6.
[4] *Id.*

AGC further argues that current economic conditions in the construction industry will not improve over the next two years,[5] and that reduced emissions resulting from the current economy gives the Board flexibility to delay the regulation and thereby reduce the financial burdens that it will impose, while still meeting the goals of the State Implementation Plan.[6]

Background of the Regulation

The Board approved the regulation for adoption on July 26, 2007, and formally adopted it on April 4, 2008. In adopting the regulation the Board specifically found that the regulation was necessary, technically feasible, and cost effective.[7] In finding that the regulations were necessary, the Board determined that in-use off-road diesel-fueled vehicles are significant contributors of emissions of oxides of nitrogen (NOx), particulate matter (PM), including PM2.5, and diesel exhaust, the last of which has been identified as a toxic air contaminant. The Board further found that the regulation would result in reductions in emissions that would prevent approximately 4,000 premature deaths and other harmful health impacts and would help California meet National Ambient Air Quality Standards (NAAQS) for ozone and PM2.5.

Subsequently, California, the nation, and the international community, in general, experienced a serious economic recession that has undisputedly impacted California businesses, including the State's construction industry. In response, as part of the 2009-2010 State budget, the California Legislature passed, and the Governor signed, AB 8 2X. Codified in Health and Safety Code section 43018.2, ARB was directed to amend the regulation to provide specified relief to affected stakeholders who have been negatively impacted by the State recession. Specifically, the legislation directed the Board to modify the NOx and PM credit provisions of the regulation to reflect vehicle retirements that reduce total fleet horsepower between March 1, 2006 and March 1, 2010, and reduced fleet activity between March 1, 2007, and March 1, 2010. It further directed the Board to amend the total cumulative NOx turnover and PM retrofit requirements for the years 2011 through 2013, to provide fleets with greater compliance flexibility with the regulation's requirements over the next three years.

Pursuant to the legislation's directives, the Board approved amendments to the regulation on July 23, 2009, with the amendments formally adopted and operative on December 3, 2009.

After adoption of the regulation in 2008, but before the enactment of AB 8 2X, AGC filed on December 15, 2008, the first of its two petitions, and requested that ARB amend and/or repeal the regulation. ARB and AGC agreed on February 4, 2009, to hold the

[5] *Id.*, at p. 7.
[6] *Id*, at p. 5.
[7] Resolution 07-19, a copy of which is attached as Attachment 1.

petition in abeyance as the parties evaluate data to determine the recession's impacts on construction fleets. With notice from either party, the petition could once again be activated and require an ARB response. To date, neither party has sought to activate the first petition.

On December 3, 2009, AGC presented ARB staff with its 2009 emissions inventory modeling analysis using the Diesel Off-Road On-Line Reporting System (DOORS)[8] data collected by ARB staff. The analysis was subsequently sent to the Board and made a part of the record of the December 11, 2009, Board hearing. At the hearing, the Board directed staff to return at its April and July 2010 Board hearings with an assessment of how the recession has impacted stakeholders subject to the regulation, using such information that is available, including the most recent fleet data that fleets are required to report no later than April 1, 2010.

Response to Petition

A. Actions Warranted by the Petition

Pursuant to the authority provided under Government Code section 11340.7, I am granting the following relief and finding the actions described below to be warranted.

1. Enforcement Advisory

I have determined that issuance of an enforcement advisory is warranted. The advisory will notify all stakeholders affected by the regulation that ARB will not take any enforcement action for noncompliance with the regulation's emission standards or other emission related requirements before ARB receives authorization from U.S. EPA.

2. Hearing before the Executive Officer to Determine Need for Further Relief from the Impacts of the Recession

I am scheduling a hearing to be held on March 11, 2010 before the Executive Officer for the purpose of receiving testimony and other relevant information on the question of whether the regulation needs to be further amended to provide additional mitigation for stakeholders that have been adversely impacted by the recession and for whom the compliance relief provided by the AB 8 2X amendments has not been adequate. At the hearing, the petitioner and affected stakeholders will be provided the opportunity to fully present information on the effects of the recession on the construction industry and other industrial sectors of the economy, in general, and off-road fleets in particular. They will also be able to present testimony and information on how the recession has

[8] DOORS is an online reporting tool designed to help fleet owners report their off-road diesel vehicle inventories and actions taken to reduce vehicle emissions to ARB, as required by the regulation.

affected emissions in the State, and why further delay of the regulation's compliance schedule is necessary and will not affect California's continuing efforts to improve air quality within its borders. I am also requesting that AGC and other stakeholders provide concrete and verifiable information to support any claims that the economy, in general, and the construction industry, specifically, will not have sufficiently rebounded from the recession by 2013.[9] The collected information will assist ARB staff in determining whether additional amendments to the regulation beyond those already adopted should be proposed to the Board.

In holding the hearing, I recognize that the present recession is the deepest recession since the Great Depression of the 1930s, that it has adversely impacted many fleets covered by the regulation, and that recovery from this recession is taking longer than many expected. I also recognize that the recession has resulted in reduced activity for many fleets and that, as a consequence, emissions are lower than forecasted in 2007, when the regulation was initially approved. However, what must be determined is the adequacy of the amendments already in place. The Executive Officer hearing will provide the best means of collecting information to make that determination.

In directing that an Executive Officer hearing be held, I have determined immediate Board action is not necessary since no emergency exists. The petition argues that the regulation must be immediately delayed by two years to prevent immediate and irreparable harm to fleets, in large part because the fleets have been adversely impacted by the current severe recession.[10] There is no dispute that a severe recession exists and that fleets have been negatively impacted. However, the AB 8 2X amendments, which became operative on December 3, 2009, have averted the need for immediate emergency action. The amendments adopted by the Board address the petition's concerns by providing a two-year delay, except for the largest fleets that were able to sustain revenues at pre-recession 2007 levels. Any fleet that has reduced its horsepower through retirement of vehicles between March 1, 2006 and March 1, 2010 will receive compliance credit for that horsepower reduction. Similarly, any fleet that has reduced its operational activity over the last several years (i.e., the difference in fleet activity between calendar year 2007 and the 12-month period bounded by March 1, 2009 to February 28, 2010) will also receive compliance credit. This effectively provides immediate compliance relief in the first years of the regulation's implementation for most fleets that have been adversely affected by the recession. For example, any fleet that has reduced its horsepower through retirements or reduced the amount that it operates by 32 percent or more will be COMPLETELY exempt from any compliance actions in 2010 or 2011 (i.e., will not be required to turn over any vehicles or install any retrofits). Fleets that have been more modestly impacted by the recession will be able to offset some of their 2010 and 2011 compliance requirements.

[9] See Petition at pages 4 and 6
[10] Petition at page 6

The AB 8 2X amendments also allow all fleets, even those unaffected by the recession, to postpone much of the compliance actions originally required for 2011 and 2012 until 2013. Fleets whose business has not been adversely impacted should financially be in position to meet the regulation's immediate 2010 requirements.[11] Moreover, it is reasonable to assume that at least some of these fleets will take advantage of the regulation's early action credit provisions.[12] This relief along with the compliance relief provided in the above-referenced advisory preclude my finding that an emergency exists. For these reasons, I cannot accept AGC's characterization that most, if not all, fleets need immediate further relief to avoid irreparable harm.[13]

Immediate action is also not required even though the AB 8 2X amendments do not address the fleet average requirements of the regulation. The petition essentially argues that the remedy provided in AB 8 2X is insufficient in that it does not address the fleet average requirements of the regulation.[14] The argument is unsupportable because AB 8 2X specifically provides relief to fleets from the regulation's best available control technology (BACT) requirements, which are a compliance alternative to the fleet average requirements. Thus, to the extent that fleets achieve compliance by meeting the regulation's BACT requirements through credits for vehicle retirements and fleet inactivity, they are under no obligation to meet the fleet average requirements. Consequently, the AB 8 2X relief effectively addresses all of the regulation's performance requirements.

B. No Action is Warranted for ARB to Request that U.S. EPA Delay Issuing California an Authorization for the Regulation

The petition requests that ARB inform U.S. EPA that it should not issue the authorization that California has requested for the regulation. I have determined that such a request is outside of the scope of the APA petitioning process, which is directed at requests for adoption, amendment, or repeal of a regulation.[15] Accordingly, no action on the request is warranted.

C. Conclusion

In conclusion, for the foregoing reasons, I am granting the following relief: ARB will issue an advisory no later than February 28, 2010, notifying stakeholders that ARB will not take any enforcement action for noncompliance with the regulation's March 1, 2010 emission standards or other emission related requirements before it receives authorization from U.S. EPA. I have further determined that an Executive Officer

[11] See e.g., title 13, Cal. Code Regs., §§ 2449(d)(1), 2449.1(a)(2)(A)2., and 2449.2(a)(2)(A)2.
[12] Title 13, Cal Code Regs , § 2449(g)(1)(G).
[13] Petition at page 4.
[14] Petition at pages 1 and 4.
[15] Govt. Code § 11340.7.

hearing to take testimony and receive information on the question of whether further amendments to the regulation, beyond those that have been adopted to date, is warranted. At the hearing, AGC and other stakeholders will have the opportunity to present testimony and documentation on the recession's impact and what additional relief stakeholders need to address those impacts.

If you have questions regarding the decision on this petition or would like to discuss the regulation, please contact Mr. Erik White, Chief, Heavy-duty Diesel In-Use Strategies Branch, at (916) 322-1017 or ewhite@arb.ca.gov or Mr. Michael Terris, Senior Staff Counsel, Office of Legal Affairs, at (916) 445-9815 or mterris@arb.ca.gov.

Sincerely,

James N. Goldstene
Executive Officer

Attachment

cc: Tom Cackette,
Chief Deputy Executive Officer

Ellen M. Peter
Chief Counsel

Bob Cross, Chief
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Erik White, Chief
Heavy-Duty Diesel In-Use Strategies Branch

Michael Terris
Senior Staff Counsel
Office of Legal Affairs

3_B_ADF_GE Responses (Page 17 – 24)

138. Comment: **Exhibit 2**

Agency Response:
This exhibit is an email from Executive Officer James Goldstene and is referred to in comment **LCFS B12-5**. As such, see the response to **LCFS B12-5**, in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **12_B_LCFS_GE**.

Exhibit 3

Land Use Changes and Consequent CO_2 Emissions due to US Corn Ethanol Production: A Comprehensive Analysis*

By

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April 2010

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FINAL REPORT

* The research underlying this report was partially funded by Argonne National Laboratory. We are deeply indebted to Dr. Michael Wang for his many contributions to this research. Throughout the process, he has consistently posed excellent questions that have stimulated more thinking and modifications on our part. Also, for this final paper, he provided an excellent set of insightful suggestions and comments that have improved the paper significantly. Of course, the authors are solely responsible for the content of and any errors in the report.

Executive Summary

The basic objective of this research was to estimate land use changes associated with US corn ethanol production up to the 15 billion gallon Renewable Fuel Standard level implied by the Energy Independence and Security Act of 2007. We also used the estimated land use changes to calculate Greenhouse Gas Emissions associated with the corn ethanol production.

The main model that was used for the analysis is a special version of the Global Trade Analysis Project (GTAP) model. It is a computable general equilibrium model that is global in scope. The version used for this analysis has up to 87 world regions and 57 economic sectors plus the biofuel sectors that were added for this analysis. There are many different versions of the GTAP model. It is used by thousands of economists around the world for analysis of trade, energy, climate change, and environmental policy issues. The model is publically available with documentation of the model and data base at www.gtap.org. The version used in this analysis contains energy and GHG emissions (GTAP-E) and also has land use (GTAP-AEZ). The name for the special version created for this work is GTAP-BIO-ADV and encompasses many changes to improve the analysis of corn ethanol:

- The three major biofuels have been incorporated into the model: corn ethanol, sugarcane ethanol, and biodiesel.
- Cropland pasture in the US and Brazil and Conservation Reserve Program lands have been added to the model.
- The energy sector demand and supply elasticities have been re-estimated and calibrated to the 2006 reality. Current demand responses are more inelastic than previously.
- Corn ethanol co-product (DDGS) has been added to the model. The treatment of production, consumption, and trade of DDGS is significantly improved.
- The structure of the livestock sector has been modified to better reflect the functioning of this important sector.
- Corn yield response to higher corn prices has been estimated econometrically and included in the model.
- The method of treating the productivity of marginal cropland has been changed so that it is now based on the ratio of net primary productivity of new cropland to existing cropland in each country and AEZ.

There are many other changes both in data and model structure, which are detailed in the report, but these are the major model and data modifications.

To evaluate the land use implications of US ethanol production we develop three groups of simulations. In the first group we calculate the land use implications of US ethanol production off of the 2001 database. This approach isolates impacts of US ethanol production from other changes which shape the world economy. In the second group of simulations, we first construct a baseline which represents changes in the world economy during the time period of 2001-2006. Then we calculate the land use impact of the US ethanol production off of the updated 2006 database, while we follow the principles of the first group of simulations for the time period of 2006-20015. Finally, in the third group of simulations we use the updated 2006 database

obtained from the second group of simulations but we assume that during the time period of 2006-2015 population and crop yields will continue to grow.

In this summary, we will first report the land use changes for the third group of simulations. Then we present emissions obtained for the three groups of simulations. Tables 1 and 2 provide the estimated land use changes broken down by US and rest of world (Table.1) and the forest pasture split (Table 2). On average 28% of the land use change occurs in the US, and 72% in the rest of the world. Forest reduction accounts for 35% of the change and pasture 65%. On average 0.12 hectares of land are needed to produce 1000 gallons of ethanol.

Table1. Simulated global land use changes due to the US ethanol production: with yield and population growth after 2006

Changes in US corn ethanol production	Land use changes (hectares)			Distribution of Land Use changes (%)			Hectares per 1000 Gallons
	Within US	Other Regions	World	Within US	Other Regions	World	
3.085 BG (2001 to 2006)	119281	320068	439349	27.1	72.9	100.0	0.14
2.145 BG (2006 to 7 BG)	58799	150754	209553	28.1	71.9	100.0	0.10
2.000 BG (7 to 9 BG)	58167	134225	192392	30.2	69.8	100.0	0.10
2.000 BG (9 to 11 BG)	60919	141118	202038	30.2	69.8	100.0	0.10
2.000 BG (11 to 13 BG)	64529	167511	232040	27.8	72.2	100.0	0.12
2.000 BG (13 to 15 BG)	69848	196148	265996	26.3	73.7	100.0	0.13
13.23 BG (2001 to 15 BG)	431544	1109824	1541368	28.0	72.0	100.0	0.12

Table 2. Simulated global land use changes due to the US ethanol production: With yield and population growth after 2006

Changes in US corn ethanol output	Land use changes (hectares)			Distribution of land use changes (%)		
	Forest	Grassland	Crop*	Forest	Grassland	Total*
3.085 BG (2001 to 2006)	-155414	-283921	439349	35.4	64.6	100.0
2.145 BG (2006 to 7 BG)	-71830	-137724	209553	34.3	65.7	100.0
2.000 BG (7 BG to 9 BG)	-67347	-125070	192392	35.0	65.0	100.0
2.000 BG (9 BG to 11 BG)	-70376	-131670	202038	34.8	65.2	100.0
2.000 BG (11 BG to 13 BG)	-79832	-152216	232040	34.4	65.6	100.0
2.000 BG (13 BG to 15 BG)	-93949	-172051	265996	35.3	64.7	100.0
13.23 BG (2001 to 15 BG)	-538749	-1002651	1541368	35.0	65.0	100.0

*The difference between the changes in cropland and the sum of forest and grassland is due to rounding

We now consider estimated emissions induced by US ethanol production. Table 3 summarizes the emissions results from the three sets of simulations, and Table 4 provides the estimated ethanol and gasoline emissions in grams per gallon of gasoline equivalent.

Table 3. Estimated land use change emissions due to U.S. ethanol production (Figures are annual CO_2 emissions in grams per gallon of ethanol)

GTAP results off of 2001 database	Average emissions	1676
	Marginal emissions	1846
GTAP results off of 2006 database	Average emissions	1407
	Marginal emissions	1446
GTAP results off of 2006 plus population & yield growth	Average emissions	1116
	Marginal emissions	1217

Table 4. Estimated well-to-wheel ethanol and gasoline emissions for average land use changes (emissions are in grams per gallon of gasoline equivalent)

Description	Ethanol Emissions	Gasoline Emissions	Ethanol GHGs vs Gasoline (percent)
Simulations Off of 2001	10342	11428	90.5
Simulations Off of 2006	9933	11428	86.9
Simulations Off of 2006 Plus population & yield growth	9490	11428	83.0

Land use change and the associated GHG emissions is a very controversial topic. Some argue it is impossible to measure such changes. Others argue that failure to measure the land use changes and the consequent GHG emissions would lead us to incorrect policy conclusions. After working on this topic for over two years, we come out between these extremes. First, with almost a third of the US corn crop today going to ethanol, it is simply not credible to argue that there are no land use change implications of corn ethanol. The valid question to ask is to what extent land use changes would occur. Second, our experience with modeling, data, and parameter estimation and assumptions leads us to conclude that one cannot escape the conclusion that modeling land use change is quite uncertain. Of course, all economic modeling is uncertain, but it is important to point out that we are dealing with a relatively wide range of estimation differences.

In some cases, the results are fairly stable regardless of the simulation. For example, the percentage of land that comes from forest ranges between 25 and 35 percent depending on the model and assumptions being used. Similarly, the fraction of land use change that occurs in the U.S. ranges between 25 and 34 percent. However, the land needed to meet the ethanol mandate ranges between 0.12 and 0.22 hectares/1000 gallons, which is a fairly wide range. The land use ethanol CO_2 emissions per gallon range between 1116 and 1676, also a fairly large range. Total ethanol CO_2 emissions due to production and consumption of gasoline (including land use) range

between 77.5 g/MJ and 84.4 g/MJ. Ethanol emissions as a fraction of gasoline emissions range between 83.0 and 90.5 percent. From these results, we feel confident that corn ethanol would meet a 10 percent savings standard. On the other hand the results suggest that corn ethanol would not meet a 20 percent emissions reduction standard. However, we cannot say that corn ethanol would not meet a 20 percent standard given the inherent uncertainty in the analysis, and potential improvement in direct emissions associated with corn farming and ethanol production.

Analysis such as that undertaken here is very complex and is limited by data availability, validity of parameters, and other modeling constraints. Economic models, like other models, are abstractions from reality. They can never perfectly depict all the forces and drivers of changes in an economy. However, the basic model used for this analysis, GTAP, has withstood the test of time and peer review. Hundreds of peer reviewed articles have been published using the GTAP data base and analytical framework. In this project, we have made many changes in the model and data base to improve its usefulness for evaluating the land use change impacts of large scale biofuels programs. Yet, uncertainties remain. In this paper, we have described the evolution of the modeling and analysis and present openly the evolution of the results. We believe quite strongly that analysis of this type must be done with models and data bases that are available to others. Replicability and innovation are critical factors for progress in science. They also are important for credibility in policy analysis.

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1. Introduction

US ethanol production has increased sharply from 1.7 billion gallons (BGs) in 2001 to about 10 BGs in 2009. According to the Renewable Fuel Standard (RFS) in the US Energy Independence and Security Act of 2007 (CRS RL34294), 2007, US corn ethanol production will reach 15 BGs in 2015. This level of ethanol production will affect agricultural activities within the US and around the world. In particular, it can cause land use changes anywhere in the world, and the implications of land use changes are complex and controversial. A sizeable ethanol production program has the potential to increase corn price, corn yield per unit of land, affect corn consumption, change corn trade, and encourage livestock producers to use byproducts of ethanol production in their animal feed rations. Land use changes associated with increased corn ethanol production are important because the land use changes can affect the CO_2 emissions associated with ethanol production and consumption.

Argonne National Laboratory (ANL) (Wang 1999, Wang et al. 1999, and 2005) has developed a life cycle model (GREET) which estimates the emissions of greenhouse gases (GHGs, including CO2, CH4, and N2O) of corn ethanol production. The GREET model classifies GHG emissions into three categories: 1) feedstock production; 2) fuel production - corn to ethanol in this case; and 3) vehicle operation. The total emissions associated with the ethanol supply chain are then compared with the analogous calculations for gasoline. At present, there is limited data on GHG emissions from direct land use changes due to biofuel production included in the GREET model. The land use consequences of biofuel production and their corresponding emissions were highlighted in the literature. The early papers published in this area show that biofuel production could have extraordinary land use implications (Searchinger et

al. 2008[1], Fargione et al. 2008). Because the land use emissions were claimed to be so large, it was deemed important to get different assessments of the possible land use changes and associated emissions. Argonne and Purdue agreed that Purdue would conduct such an analysis using the Global Trade Analysis Project (GTAP) modeling framework and data base. In order to do this analysis with GTAP, several model and data base modifications were required, and these are described in this report.

This report aims to evaluate land use changes and CO_2 emissions induced by US corn ethanol production for several alternative configurations and assumptions. The results of this paper provide information on land use related emissions due to ethanol production that can be combined with the emissions calculated in GREET to produce total green house gas (GHG) emissions associated with corn ethanol production and use. This total can then be compared with gasoline to determine the net gain/loss for corn ethanol production and use compared with gasoline.

To achieve this goal we use three major components. First, we use a computational general equilibrium (CGE) model to assess the economic impacts of ethanol production and its land use implications for the world under alternative sets of assumptions. The CGE model is a special version of the Global Trade Analysis Project (GTAP) model (Hertel, 1997) of the global economy which was recently developed by Taheripour, Hertel, and Tyner (2009) to evaluate impacts of biofuel production for the global livestock industry.

The second component consists of a module which converts land use changes estimated in GTAP to the associated CO_2 emissions. This module generates CO_2 emissions factors which we use to convert land use changes into CO_2 emissions based on the Woods Hole Research Center data set on the soil and land cover carbon profiles. The Woods Hole data set divides the

[1] We will henceforth refer to this paper as SEA

whole world into 10 regions and provides data on the soil and land cover carbon profiles for each region[2].

Finally, we convert the land use related emissions calculated in module two to emissions per gallon of 100% ethanol and add those emissions to those calculated in GREET to get total emissions. This can be done either within the GREET model or by direct calculations. For this paper we have done the calculations directly.

In this report rather than using the terms direct and indirect emissions, as is commonly reported in the literature, we categorize the emissions as those calculated in GREET and associated with use of corn for producing and consuming ethanol and emissions associated with land use changes. By some definitions of the term indirect, these would be labeled indirect emissions, but to avoid confusion we label them emissions associated with induced land use changes.

We should from the outset acknowledge that land use change is a complicated process. It is driven by many factors and varies through time. There are social as well as economic factors involved in the complicated process of evolving land use. The factors vary by culture, region, and economy.[3] Obviously neither this analysis nor any analysis can capture all the factors involved in land use change. What we have attempted to do is to isolate the impacts of a substantial increase in US corn based biofuels production. Since corn is a globally produced and consumed commodity, these impacts will be of necessity global. The impacts will be driven to a

[2] In our earlier report (Tyner, Taheripour, and Baldos, 2009) we applied the IPCC data set as well. The IPCC data set provides data on the soil and land cover carbon profiles at a global scale with no specification of geographical distribution. The IPCC land use emissions factors are much larger than the regional emissions factors derived from the Woods Hole data set. In this report we only apply the land use emissions factors obtained from the Woods Hole data set. The IPCC data set is too aggregate to be useful in this analysis. Since our results are down to the AEZ and country level, we took advantage of the greater disaggregation in the Woods Hole data.

[3] We are indebted to Gbadebo Oladosu and Keith Kline of Oak Ridge National Laboratory for providing data and useful perspeetives on the land use change process.

significant degree by changes in global supply and demand of feed grains. Thus, we have used a global general equilibrium model which can capture many of these market mediated effects.

The rest of this paper is organized as follows. We first introduce the GTAP model and modifications which are made in this model to make it suitable for analyzing economic and environmental consequences of biofuels. Then we explain our simulations and assumptions behind them along with the land use results from these simulations. After that we introduce the land use CO_2 emission factors which we use to convert land use changes into CO_2 emissions. Finally, we present CO_2 emissions induced by US ethanol production due to land use changes and compare these results with results from other studies.

2. Land use changes due to US ethanol production: GTAP model

To evaluate the impacts of the US corn ethanol production on global land use we need a model which is global in scope, and which links global production, consumption and trade. In addition, the model should properly link energy, biofuel, and agricultural markets. Since biofuel, crop, and livestock industries compete through the land market, the model should link these activities through the land market as well. Furthermore, biofuels byproducts, which can be used in animal feedstuffs, bridge these industries through a triangular relationship which alters the nature of competition among these industries. All of this has led us to use a special purpose version of the Global Trade Analysis Project (GTAP) model and its database. GTAP is a computable general equilibrium (CGE) model which considers production, consumption, and trade of goods and services by region and at a global scale. Figure 1 represents an illustrative overview of the GTAP model.

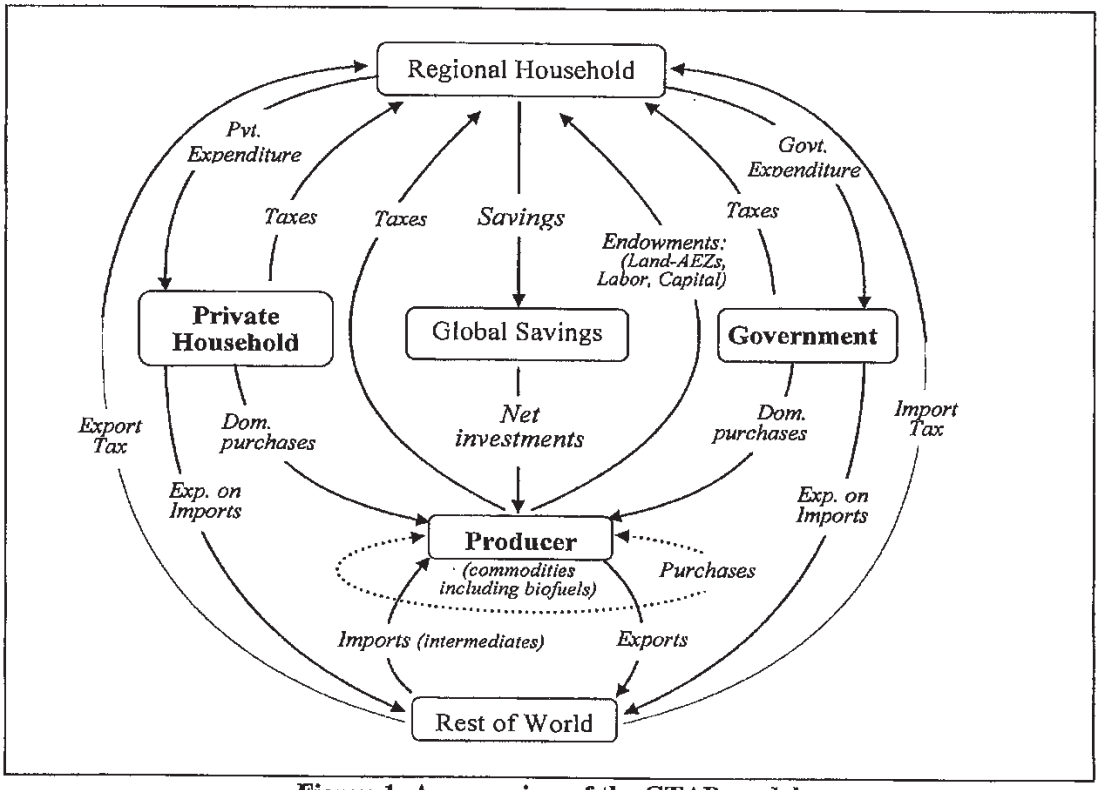


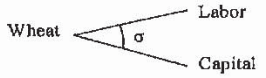
Figure 1. An overview of the GTAP model

In GTAP each country or composite region is represented by a regional household which collects all incomes generated by the economy and allocates them among three components of the final demand: Private Household, Government, and Savings (for details see Brockmeier (1996)). In this model households (consumers) maximize their utilities according to their budget constraints and producers minimize their production costs subject to resource constraints. The model determines demands for and supplies of goods and services according to consumer and producer behaviors. Resources are labor, capital, land, and natural resources, and they owned by consumers. In GTAP, markets are competitive, consumers and producers are price takers, and utility and production functions usually follow the constant elasticity of substitution (CES)

functional forms[4]. We will introduce the production and consumption structures of GTAP later in this report.

The GTAP model simulates the world economy using a global database which contains input-output tables for almost all countries. These tables provide detailed information on production and consumption of commodities and services along with investment and bilateral trade among regions. This database also includes payments to labor, capital, and land (for details see Dimaranan (2006)). GTAP data come from a multitude of sources. The country input-output tables are generally provided by contributors in the countries who have access to national statistics data. Trade data come from UN sources and USDA. Protection data come from several sources, but CEPII in France is the major source. Energy data come from the IEA in Paris. There are other sources as well. The GTAP staff at Purdue set the standards for data and assure quality and consistency. The database also includes the most updated global land cover and land uses database by region disaggregated into 18 Agro Ecological Zones (AEZs). These AEZs share common climate, precipitation and moisture conditions. The land cover and land use database is based on the Center for Sustainability and Global Environment (SAGE) database (for more information on the land use database see Lee et al. (2005)). The land use data base provides information on global crop yields as well. Note that the land use database excludes inaccessible forests. The version 6 of the GTAP data base covers 57 groups of commodities and services for

[4] Here, we use a simple graphical example to explain a constant elasticity of substitution functional form. Consider a producer which can use labor (L) and capital (k) to produce wheat (W). The following simple figure depicts the production function of this farmer:



In this graph σ represent the elasticity of substitution between labor and capital. If the farmer can only use labor and capital in a fixed proportion, then σ=0. However, if the farmer can reduce number of work hours and increase the amount of capital (say due to an increase in wage rate) to achieve its production goal, then σ is a number greater than zero. In general, σ can take any number between zero and infinity when we consider substitution among inputs or among consumption of goods and services.

87 countries and regions. Version 6 is based on 2001 data, and was the starting point for the biofuels analysis reported in this paper.

The GTAP model and its data base have been frequently modified and improved in the past three years to develop an improved tool for examining the economic and environmental consequences of the global biofuel production. In this process Taheripour et al. (2007) have explicitly introduced three biofuel commodities (including ethanol from food grains, ethanol from sugarcane, and biodiesel from oilseeds) into the GTAP data base version 6.

Birur, Hertel, and Tyner (2008) have incorporated biofuels into the GTAP-E model[5]. They augment the model by adding the possibility for substitutability between biofuels and petroleum products. We will henceforth refer to this model as GTAP-BIO-ADV (advanced GTAP-BIO model). Figures 2 and 3 represent the structure of consumption and production sides of this model. In these figures CES means constant elasticity of substitution (as explained in footnote 4 above) and CDE stands for constant difference elasticity and is the means of expressing household preferences in GTAP.

[5] GTAP-E was originally developed by Burniaux and Truong (2002) to incorporate energy into the GTAP framework, and recently modified by McDougall and Golub (2007).

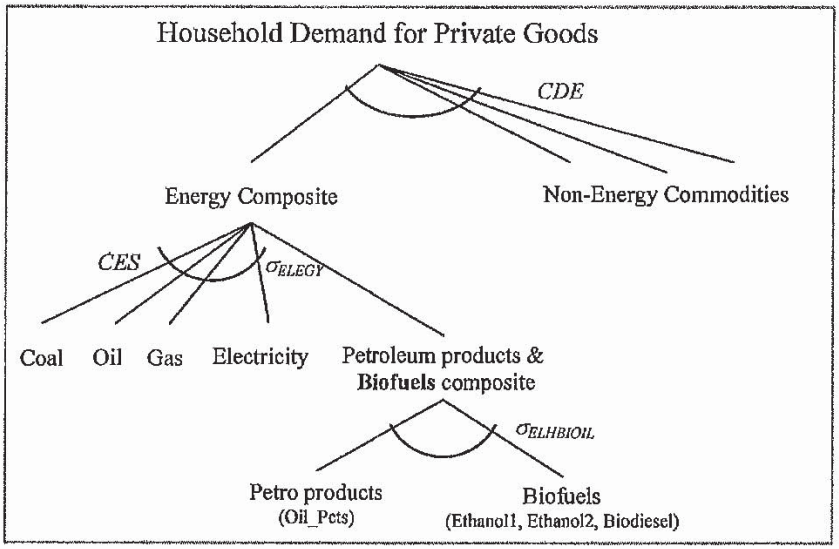


Figure 2. Structure of consumption side of the GTAP-BIO-ADV model

Figure 2 indicates that households could use biofuel as a substitute for petroleum products in GTAP-BIO-ADV. On the other hand, Figure 3 shows that at the bottom-most level of the production side biofuels are a compliment to petroleum products in the production process. It should be noted here that in a general equilibrium model like GTAP, all the equations are solved simultaneously, so it is not a stepwise solution process.

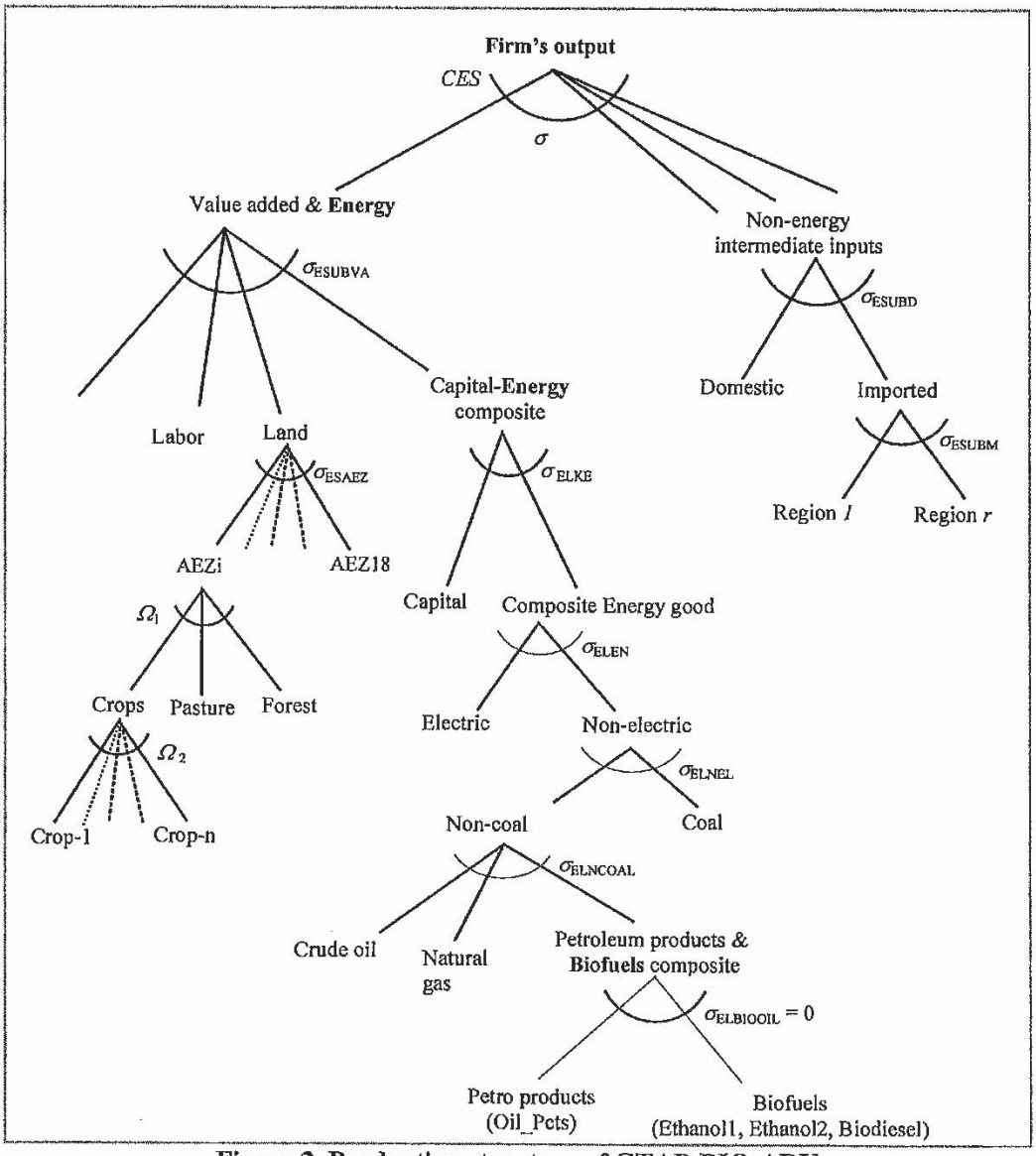


Figure 3. Production structure of GTAP-BIO-ADV

Hertel, Tyner, and Birur (2008) have recently augmented this model with a land use module to better depict the global competition for land among land use sectors. The land use module traces changes in the demand for land across the world at the AEZ level and thereby captures the potential for real competition between alternative land uses. In this module land

does not move across AEZs. However, distribution of land across its alternative uses can change within each AEZ. Alternative uses of land are: forest, grassland, and cropland. In this module livestock producers compete to use grassland, and there is competition among agricultural activities to use croplands. Corn is in the coarse grains category along with sorghum, oats, and barley. However, in the US, that grouping is mostly corn. For example, in 2009, corn constituted 95.4% of the coarse grains production (by weight). Most of the rest was sorghum, which also could be used for biofuels. There is no need to separate corn from the other coarse grains.

Recently, Birur (2010) has added two new land categories of cropland-pasture and unused cropland (e.g. retired cropland under the US Conservation Reserve Program (CRP)) into supply of land. Figure 4 represents the new structure of land supply in the modified model.

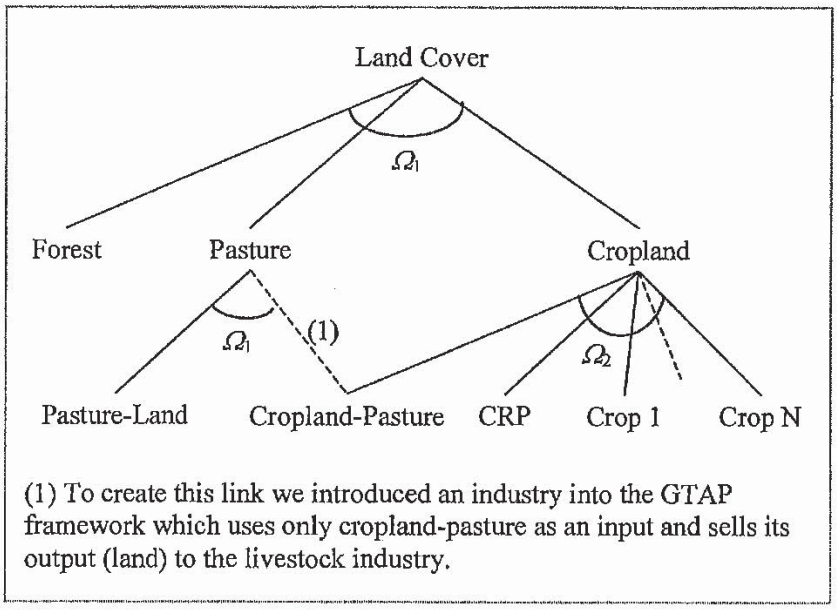


Figure 4. Land cover and land use activities in the GTAP-BIO-ADV

In the new land supply tree cropland pasture and unused cropland (mainly CRP) are explicitly defined as components of cropland. CRP land mainly generates environmental benefits. Hence, this type of land is introduced as an input into the sector which provides these

services (i.e. Oth_Ind_Se). Cropland-pasture is an input into livestock industry. To facilitate transition of cropland-pasture from livestock industry to crop production and vice versa, an industry is added to the model which uses cropland-pasture as an input and sells its output (cropland-pasture) to the livestock industry. This industry competes in the land market with crops. Finally, the livestock industry combines cropland-pasture with pasture land in its production function as shown in Figure 5. This figure indicates that the livestock industry combines pasture land with cropland-pasture in the value added nest and uses feed and non-feed inputs in its production function.

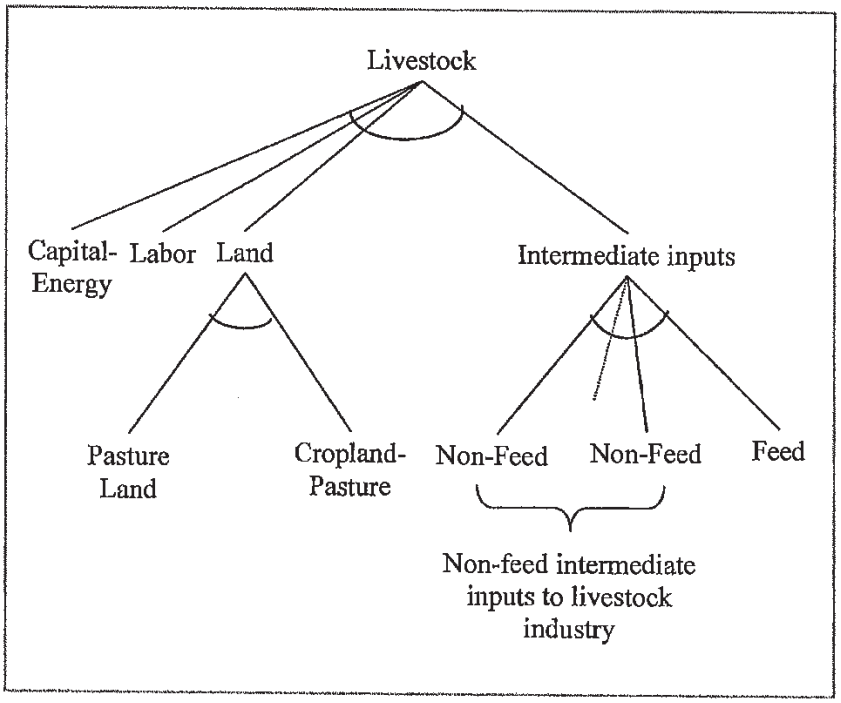


Figure 5. Production structure of the livestock industry

The land use module determines expansion of cropland and its distribution among agricultural activities according to two important parameters: price elasticity of yield and ratio of productivities of marginal and average lands. The price elasticity of yield measures changes in

crop yield due to the changes in crop price. In the simulations reported in this report we assumed that the price elasticity of yield is equal to 0.25. Keeney and Hertel (2008) have provided a detailed discussion on this parameter along with econometric evidence behind it.

The ratio of marginal and average productivities measures the productivity of new cropland versus the productivity of existing cropland. We will henceforth refer to this ratio as ETA. In our earlier work we were assumed that ETA=0.66 all across the world. In this report we use a set of regional ETAs at the AEZ level which is obtained from a bio-process-based biogeochemistry model (Terrestrial Ecosystem Model (TEM): Zhuang et al., 2003) along with spatially referenced information on climate, elevation, soils, and vegetation land use data. The new regional ETAs vary across the world and among AEZs. Appendix A represents these ETAs along with more details on their calculation processes. The new estimated ETA values are now included in the model by country and AEZ.

A major attempt has been made to introduce production, consumption, and trade of biofuel byproducts into the GTAP modeling framework. Taheripour et al. (2010) and Taheripour, Hertel, and Tyner (2009) represent the latest modifications in this area. These papers extend the original GTAP-BIO database (Taheripour et al. 2007) in several directions to properly trace the links among biofuel, vegetable oil, food, feed, and livestock industries. Unlike the initial database these papers distinguish between feedstock of the US and EU ethanol industries. In the modified GTAP-BIO database, the US uses corn and EU uses wheat in ethanol production. Following the original work, the ethanol industry also produces distillers dried grains with solubles (DDGS). They also split the "other food products" industry into two distinct industries: processed food and processed feed. In addition, they split the vegetable oil sector into two distinct industries: crude vegetable oil and refined vegetable oil. The crude vegetable oil sector

uses oilseeds and produces crude vegetable oil (as the main product) and oilseed meal (as the byproduct). Unlike the original GTAP-BIO database which directly converts oilseeds to biodiesel, they introduce a biodiesel production technology which uses crude vegetable oil and other inputs to produce biodiesel.

In addition, the latter paper uses a three level nesting structure for the demand for animal feedstuffs in the livestock industry which brings more flexibility into this part of the model. Figure 6 depicts this nesting structure. At the lower level of this nesting structure DDGS and coarse grains are combined to create an energy feed. At this level oilseeds and oilseed meals are combined to create a protein feed as well for countries that use oilseeds directly as feed. At a higher level the protein and energy feed ingredients are combined. At this level other crops also are bundled together. The livestock industry receives some inputs from processed livestock industry as well, and these materials are bundled together at the second level too. Finally, all feed ingredients are combined to create the feed composite.

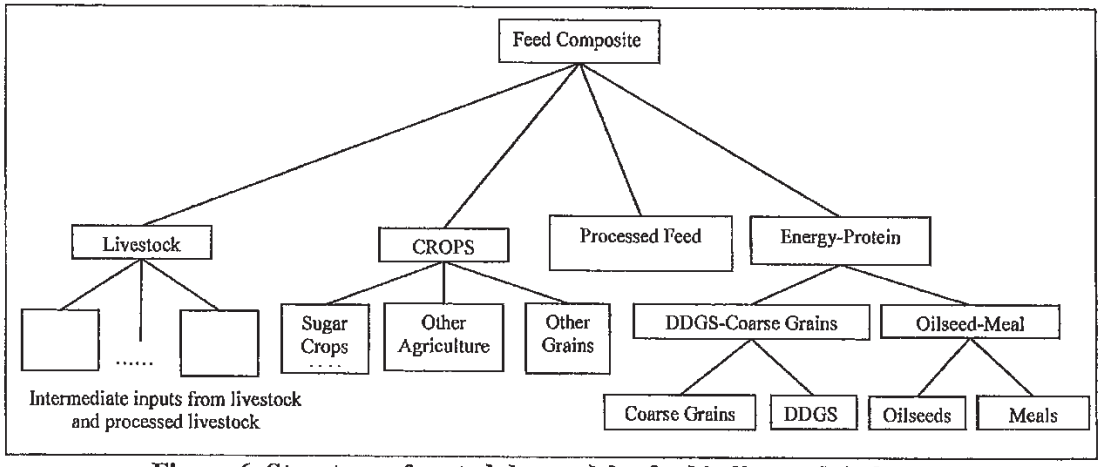


Figure 6. Structure of nested demand for feed in livestock industry

They assigned elasticities of substitution to the different components of the demand for feed to replicate changes in the prices of DDGS and meals in the US and EU during the time

period of 2001-2006. In addition, they did several experimental simulations and sensitivity tests to reach displacement ratios between DDGS, grains, oilseeds, and oilseed meals according to the literature in this area. Since oilseeds and oilseed meals are good substitutes in some regions, they applied a relatively high elasticity of substitution, 20, between these two feed materials for all types of animal species. Following the literature, they used values of 25, 30, and 20 for the elasticities of substitution between coarse grains and DDGS in the dairy farms, other ruminant, and non-ruminant feed structure, respectively. They also applied a non zero and small value, 0.3, for the elasticity of substitution between the energy and protein feedstuffs because DDGS could displace a portion of meals in some feed rations, as shown in Arora, Wu, and Wang (2008) and Fabiosa (2009). In the composite of other crops and composite of processed livestock inputs they applied elasticities of substitution of 1.5 for all types of livestock industry. Finally, following Keeney and Hertel (2005) they used 0.9 for the elasticity of substitution at the higher level of the feed demand nest.

Here we use some GTAP simulation results to show how these elasticities shape the cost structure of the livestock industry. To accomplish this task we use the results obtained from the simulations introduced in the next section of this report. In particular, we use the results of the first simulation of the second group of experiments. This particular simulation replicates transition of the global economy from 2001 to 2006. The results of this simulation predict that the cost shares of coarse grain, other crops, and meals in the US livestock industries declined during the time period of 2001-2006, while the cost share of DDGS increased. The largest substitution is DDGS for coarse grains, but there is also substitution for other crops and oilseed meals, depending on the livestock species. Note that we dropped processed feed from the list of

animal feeds to highlight the changes in the shares of crops, DDGS, and meals in this time period (Table 1).

Table 1. Cost shares of major feed items in the US livestock industries in 2001 and 2006*

Feed Items	2001			2006		
	Dairy	Meat Ruminant	Non-Ruminant	Dairy	Meat Ruminant	Non-Ruminant
Coarse Grains	67.6	68.4	82.9	64.9	63.8	83.0
Other crops	6.4	10.4	2.9	6.0	9.7	2.7
DDGS	5.6	6.4	1.1	9.2	11.5	1.6
Oilseeds meals	20.3	14.9	13.1	19.9	14.9	12.6

*Processed feed is dropped from this table to highlight shares of items listed in the table.

To evaluate the land use implications of US ethanol production we use a new model which includes all modifications and improvements which have been made in the GTAP-BIO-ADV model and its data base described above and in the associated references. In short this model has the following specifications:

1) It covers production, consumption, and trade of three types of biofuels: ethanol from crops, ethanol from sugarcane, and biodiesel from crude vegetable oil.
2) By products are DDGS and oilseeds meals.
3) The crude vegetable oil industry uses oilseeds and produces crude vegetable oil and oilseed meals.
4) The biodiesel industry uses crude vegetable oil to produce biodiesel.
5) The demand for feedstuffs follows a three level nesting structure.
6) The land module handles two new land categories of unused cropland and cropland pasture. While the model could trace changes in these two groups of land across the world, we have data on cropland pasture for the US and Brazil and data on CRP only for the US.

7) We have calibrated ETA for each AEZ and region instead of using the globally fixed ETA parameter as in the past.
8) Energy demand and supply elasticities have been re-calibrated for this version.
9) In this report we divide the world economy into 19 regions, 34 groups of commodities and services, 32 industries, and 5 groups of endowments. The list of regions, commodities, industries and endowments are shown in Appendix B.
10) In this report when we shock US ethanol, we hold production of other biofuels constant.

3. GTAP simulations and their results

To evaluate the land use implications of US ethanol production we develop three groups of simulations. In the first group we follow the approach that we used in our earlier report (Tyner, Taheripour, and Baldos, 2009). In this approach, we calculate the land use implications of US ethanol production off of the 2001 database. This approach isolates impacts of US ethanol production from other changes which shape the world economy. This method assumes that other factors such as population growth, yield improvement, and economic growth do not affect the land use implications of producing more ethanol from agricultural resources. Hertel et al. (2010) provide more insights on this approach. While this approach uses the 2001 starting point, it is different from our January 2009 draft results in that all the model changes described above have been included in this first set of simulations.

In the second group of simulations, we first construct a baseline which represents changes in the world economy during the time period of 2001-2006. Then we calculate the land use impact of the US ethanol production off of the updated 2006 database, while we follow the principles of the first group of simulations for the time period of 2006-2015. Finally, in the third

group of simulations we use the updated 2006 database obtained from the second group of simulations, but we assume that during the time period of 2006-2015 population and crop yields will continue to grow. These are two important factors which could alter the land use impacts of ethanol production in the future. These three groups of simulations and their results are described in the rest of this section.

Group 1: Simulations with no economic and yield growth and 2001 base

We calculate the land use implications of the US ethanol production for the following 6 time segments:

- Ethanol production from 2001 to 2006 level.
- Ethanol production from 2006 level to 7 B gallons,
- Ethanol production from 7 B to 15 B gallons by increments of 2 B gallons.

The global biofuel industry has followed a rapid growth path during the time period of 2001-2006. The historical observations from this time period have been used to calibrate the biofuel-parameters of the model (Hertel, Tyner, and Birur, 2008). Then we consider gradual increases in the production of US ethanol after 2006 to evaluate marginal impacts of ethanol production. For this purpose we first increase the US ethanol production from its 2006 level (4.855 BG) to 7 B gallons. Thereafter we increase ethanol production by increments of 2 B gallons to achieve the goal of 15 B gallons of ethanol in 2015.

The detailed global land use changes obtained from the first group of simulations are shown in Appendix C. Table 2 summarizes these results. These results indicate that producing 13.23 BGs of ethanol (from the 2001 production level to 15 BGs) requires about 2.96 million hectares of additional land, of which 1.01 million hectares (34%) are expected to be in the US, with the reminder (1.95 million hectares) in other regions (66%). This result suggests that the

land use changes due to US ethanol production will mainly take place outside the US. Results from this group of simulations also indicate that the size of required land to achieve the 15 BGs ethanol production is much smaller than the land use changes suggested by a simple calculation which ignores important factors that could mitigate land use impacts of ethanol production[6]. Several factors mitigate the land use consequences of ethanol production. Among them are: less corn consumption in the livestock industry due to using more DDGS in the livestock industry, reductions in output of the livestock industry, reallocation of croplands across the world among alternative crops, and higher yields in crop production due to higher prices. Hertel et al. 2010 have decomposed contributions of these factors in mitigating the land use impacts of ethanol production.

Table 2. Global land use changes due to the US ethanol production: Off of 2001 database

Changes in US corn ethanol production	Land use changes (hectares)			Distribution of land use changes (%)			Hectares per 1000 gallons
	Within US	Other Regions	World	Within US	Other Regions	World	
3.085 BG (2001 to 2006)	227982	382394	610376	37.4	62.6	100.0	0.20
2.145 BG (2006 to 7 BG)	162558	297766	460324	35.3	64.7	100.0	0.21
2.000 BG (7 to 9 BG)	152990	295051	448041	34.1	65.9	100.0	0.22
2.000 BG (9 to 11 BG)	154018	310639	464657	33.1	66.9	100.0	0.23
2.000 BG (11 to 13 BG)	154706	325639	480345	32.2	67.8	100.0	0.24
2.000 BG (13 to 15 BG)	155000	340311	495311	31.3	68.7	100.0	0.25
13.23 BG (2001 to 15 BG)	1007253	1951800	2959053	34.0	66.0	100.0	0.22

The magnitude of land requirement to increase US ethanol production from its 2001 level to 15 BG obtained from these simulations is smaller than its corresponding value in our earlier report (Tyner, Taheripour, and Baldos, 2009) by about 16.7% (i.e. 2.96 million hectares versus 3.55 million hectares). Two major modifications in the GTAP model contribute to this reduction.

[6] One can determine land use changes due to the US ethanol production by multiplying corn yield (370 bushels per hectare of land) by a corn to ethanol conversion factor (e.g. 2.7 gallons per bushel of corn). This simple approach leads to 1000 gallons of ethanol per hectare of land. Hence, based on this simple calculation, increasing ethanol production from its 2001 level (1.77 BG) to 15 BG needs about 13 million hectares of land.

A portion of this reduction is associated with the land conversion factors. As noted earlier in this report we apply a set of regional land conversion factors at the AEZ level. These land conversion factors in several AEZs are higher than the single conversion factor of 0.66 which we used in our earlier work (see Appendix A).

Introducing the new land categories (cropland pasture and unused land[7]) into the model also contributes to the reduction in land requirement. In particular, in the US and Brazil in the presence of cropland pasture farmers convert a portion of this type of land to crop production. For example, an increase in US ethanol production from its 2001 level to 15 BG brings about 1.2 million hectares of cropland pastures into crop production, but not only to corn production. Indeed, a portion of this land conversion prevents sharp reductions in production of other crops. It is important to note that the competition between crop and livestock industry prevents full conversion of cropland pasture to crop production.

These two modifications not only reduce the land requirement of ethanol production. They also alleviate the adverse impact of ethanol production on the prices and consumption of crops.

Table 2 also indicates that the required land for producing 1000 gallons of ethanol grows as we move to higher levels of ethanol production. For example, for the 2001 to 2006 simulation, an additional 3.085 B gallons of ethanol triggers global land use changes of roughly 610,376 hectares. This is equal to 0.20 hectares per 1000 gallons of ethanol. However, for the 13 BGs to the 15 BGs simulation, an additional 1000 gallons of ethanol requires 0.25 hectares of land. To increase ethanol production from the 2001 level to 15 BGs, we need an average of 0.22 hectares of land per 1000 gallons of ethanol. The marginal level (0.25) is higher than the average (0.22),

[7] In these simulations we hold the area of US CRP land constant.

which would be expected because as more land comes into production, the yields on the incremental area would be lower.

Table 3 depicts another aspect of the land use implications of US ethanol production. This table shows the distribution of land use changes between forest and grassland. About 24.7% of the required croplands which are needed to increase ethanol production from its 2001 level to 15 BGs come from forest, and the rest (75.3%) come from grasslands. Table 3 also indicates that as we move to higher levels of ethanol production the portion of forests in the converted land into crop production increases very slightly (from 23.5 % in 2001 to 25.1% at the 15 BGs ethanol production.

Table 3. Global land use changes due to the US ethanol production: Off of 2001 database

Changes in US corn ethanol output	Land use changes (hectares)			Distribution of land use changes (%)		
	Forest	Grassland	Crop*	Forest	Grassland	Total*
3.085 BG (2001 to 2006)	-143716	-466652	610376	23.5	76.5	100.0
2.145 BG (2006 to 7 BG)	-114409	-345912	460324	24.9	75.1	100.0
2.000 BG (7 BG to 9 BG)	-112330	-335712	448041	25.1	74.9	100.0
2.000 BG (9 BG to 11 BG)	-116795	-347864	464657	25.1	74.9	100.0
2.000 BG (11 BG to 13 BG)	-120688	-359650	480345	25.1	74.9	100.0
2.000 BG (13 BG to 15 BG)	-124151	-371156	495311	25.1	74.9	100.0
13.23 BG (2001 to 15 BG)	-732089	-2226946	2959053	24.7	75.3	100.0

*The difference between the changes in cropland and the sum of forest and grassland is due to rounding. Cropland pasture is included in cropland.

In the absence of crop yield growth, the increasing global land use change given equal increments of US ethanol production is explained by the differences in the productivity of available lands. Productive lands are employed first before marginal lands, which have lower productivity and lower yields. At low levels of production, more productive lands are available; hence, less land is required to produce additional ethanol. However, at high levels of production, most of the productive land is already being used, and only marginal land is available. Given

this, more marginal land is required to produce the same increment of US corn ethanol production.

Group 2: Simulations with updated baseline for the time period of 2001-2006

The global economy changed significantly over the 2001-2006 period. Countries followed different economic growth paths, population increased everywhere at different rates, land productivity rapidly increased in many regions (with some exceptions), and technology has improved in many areas. These are important factors which could alter the land use implications of biofuels. In the second group of simulations we take these factors into account.

To accomplish this task we developed a database which includes data on: crop production, harvested area, forest areas, gross capital formation, labor force (skilled and unskilled), gross domestic product, and population for the whole world at the country level. Then we used this data set to generate a baseline which replicates transition of the global economy from 2001 to 2006, while we targeted global biofuel production during this time period in the presence of population, income, and yield growths. In building the baseline we guide the model to replicate the historical paths of changes in harvested area across the world as well. Furthermore, we trace changes in global forest area to match our land use results with the historical changes in forest areas during the time period of 2001-2006. We adjusted rates of technological improvements to trace changes in cropland and forest areas.

Data sources

To construct the baseline the following data items were collected:

1- Population: World population figures by country were obtained from the UN website for 2001-2006. Then the population figures by region were calculated for

our GTAP aggregation[8]. Finally, the percentage change in population between 2001 and 2006 was calculated for each region (see table 4).

2- GDP: Real GDP figures by country were obtained from the World Development Index (WDI) database for 2001-2006. Then the GDP figures by region were calculated for our GTAP aggregation. Finally, the percentage change in GDP between 2001 and 2006 was calculated for each region (see table 4).

3- Capital: Real capital formation figures by country were obtained from the WDI database for 2001-2006. Then the capital formation figures by region were calculated for our GTAP aggregation. Finally, the percentage change in capital formation between 2001 and 2006 was calculated for each region (see table 4).

4- Labor: Labor force figures by country were obtained from the WDI database for 2001-2006. Then the labor force figures by region were calculated for our GTAP aggregation. Finally, the percentage change in labor force between 2001 and 2006 was calculated for each region (see table 4). We followed Walmsley, Dimaranan, and McDougall (2000) to split labor force into groups of skilled labor and unskilled labor.

5- Crop production: Crop production figures by crop type and by country were obtained from the FAO website for 2001-2006. Then crop production figures by region were calculated for our GTAP aggregation for 2001-2006.

6- Harvested Area: Harvested areas by crop type and by country were obtained from the FAO website for 2001-2006. Then the harvested areas by region were calculated for our GTAP aggregation for 2001-2006.

[8] The aggregation schedule is shown in Appendix B, Table B-2.

7- Yield: Yields were calculated by region and by crop using items 5 and 6 introduced above. Since yield fluctuates over time, annual percentage changes in yields were calculated. Then we obtained the average of percentage changes in yield over the time period of 2001-2006 for each crop within each region. Table 5 reports the cumulative yield change for each region and crop category over the five years. Thus these percentages are roughly five times the annual growth rates.

8- Global forest export price - Values and quantities of exports of forestry products were obtained from the FAO website for 2001-2006. These figures were used in defining a global price index for forest products to shape technological progress in forest industry.

9- Finally, we used the FAO assessment of changes in global forest areas to track changes in the global forest areas (FAO, 2006). The FAO assessment covers the time period of 2000-2005, while we need changes in 2001-2006. So we assumed that changes in forest areas within the period of 2000-2005 are similar to the changes in the time period of 2001-2006.

Table 4. Percentage changes in macro economic variables (2001-2006)

Regions	Population	GDP	Skilled labor	Unskilled labor	Capital
1 USA	5.2	15.0	5.7	5.2	18.9
2 EU27	1.82	10.2	7.4	-1.1	13.1
3 BRAZIL	6.88	17.2	24.4	8.5	11.1
4 CAN	5.31	14.6	9.1	8.3	34.0
5 JAPAN	0.59	8.8	0.2	-4.1	0.7
6 CHIHKG	3.59	59.0	17.5	4.7	83.6
7 INDIA	8.51	45.9	27.5	8.7	94.8
8 C_C_Amer	6.41	16.8	33.7	6.8	25.4
9 S_o_Amer	7.19	24.4	50.2	10.1	54.4
10 E_Asia	2.75	25.9	15.1	5.3	21.6
11 Mala_Indo	7.18	29.1	56.5	9.0	30.1
12 R_SE_Asia	7.2	33.7	26.6	9.3	43.0
13 R_S_Asia	10.8	32.5	34.4	15.5	39.0
14 Russia	-2.38	37.7	2.2	1.2	69.6
15 Oth_CEE_CIS	2.27	25.5	14.9	-2.2	40.0
16 Oth_Europe	2.27	25.5	14.9	-2.2	40.0
17 MEAS_NAfr	10.18	26.7	30.7	19.1	47.8
18 S_S_AFR	13.47	27.5	17.3	13.6	45.2
19 Oceania	7.79	17.4	11.1	8.5	54.8

Table 5. Percentage change in yield (accumulation of growth rates 2001-2006)

Region\Crop	Wheat and Paddy Rice	Coarse Grains	Oilseeds	Sugarcane	Other Agriculture
1 USA	-2.3	11.0	11.6	1.8	-7.3
2 EU27	4.0	7.3	13.5	7.8	-1.8
3 BRAZIL	12.4	22.8	3.5	8.1	9.3
4 CAN	10.8	10.2	14.4	33.3	18.1
5 JAPAN	-4.1	-18.4	-8.6	5.1	-0.5
6 CHIHKG	6.3	17.0	5.6	42.6	5.2
7 INDIA	5.3	16.4	15.6	-4.1	-2.4
8 C_C_Amer	4.0	13.2	28.6	13.2	5.4
9 S_o_Amer	10.0	9.0	-0.7	6.4	3.5
10 E_Asia	5.6	48.3	3.6	0.0	5.6
11 Mala_Indo	4.3	19.4	27.4	9.3	19.8
12 R_SE_Asia	10.1	18.1	10.8	-4.6	15.6
13 R_S_Asia	6.8	37.8	-5.1	4.4	11.5
14 Russia	20.8	17.2	22.2	48.8	15.0
15 Oth_CEE_CIS	15.1	26.0	16.7	22.6	13.5
16 Oth_Europe	15.1	26.0	16.7	22.6	13.5
17 MEAS_NAfr	20.3	25.3	46.6	4.3	1.7
18 S_S_AFR	6.4	9.8	10.2	-5.7	3.4
19 Oceania	10.9	-9.6	0.7	2.2	17.3

To generate the 2006 baseline, we shock major macroeconomic variables according to the historical observations for the time period of 2001-2006. In particular, we shocked GDP, gross capital formation, labor force, and population at the regional level. We also introduced shocks to increase global biofuels outputs according to actual observations for the same time period. In addition to these shocks, we guide the model to replicate observed improvement in yield over the time period of 2001 to 2006 by crop and by region. Finally, we introduced technological changes in input output ratios to replicate regional changes in harvested area during the time period of 2001-2006. Furthermore we guide the model to trace changes in forest area during the baseline time period. Appendix D shows the list of implemented shocks. This experiment provides us a new database which represents the world economy in 2006 in the presence of changes in the major derivers of the world economy. To separate out the impacts of

the US ethanol program from other derivers of the world economy we repeat this experiment without the US ethanol shock. The difference between the land use implications of these two simulations gives us the impact of the US ethanol program for the time period of 2001-2006.

Then we used the updated 2006 database to evaluate the land use impacts of increasing US ethanol from its 2006 level to 15 BG incrementally. The global land use implications obtained from the second group of simulations are shown in Appendix C. Table 6 summarizes these results.

Table 6. Simulated global land use changes due to the US ethanol production: Off of updated baseline

Changes in US corn ethanol production	Land use changes (hectares)			Distribution of Land Use changes (%)			Hectares per 1000 gallons
	Within US	Other Regions	World	Within US	Other Regions	World	
3.085 BG (2001 to 2006)	119281	320068	439349	27.1	72.9	100.0	0.14
2.145 BG (2006 to 7 BG)	76003	225500	301503	25.2	74.8	100.0	0.14
2.000 BG (7 to 9 BG)	71207	217720	288927	24.6	75.4	100.0	0.14
2.000 BG (9 to 11 BG)	71783	223877	295660	24.3	75.7	100.0	0.15
2.000 BG (11 to 13 BG)	72547	228732	301279	24.1	75.9	100.0	0.15
2.000 BG (13 to 15 BG)	73459	233064	306524	24.0	76.0	100.0	0.15
13.23 BG (2001 to 15 BG)	484280	1448962	1933242	25.1	74.9	100.0	0.15

The results obtained from the second group of simulations indicate that we need 1.93 million hectares of cropland to increase ethanol production from the 2001 level to 15 BGs. This figure is smaller than its corresponding figure obtained from the first group of simulations by 34.7%. Two main factors contribute to this reduction. During the time period of 2001-2006 crop yields are growing faster than the demands for crops globally. This reduces the size of land use changes in this period. Then when we calculate the land use implications of US ethanol for the time period of 2006-2015 from the updated database of 2006, we get smaller land use changes because crop yields are higher in the updated database.

In the second group of simulations cropland pasture moves to crop production faster than in the first group of the simulations as well. In the presence of economic growth about 3.9 million hectares of cropland pasture will move to crop production.

Table 7 represents distributions of land use changes between forest and pasture for the second group of simulations. In this group of simulations on average about 34.8% of required land for ethanol production comes from forest land. This figure is higher than the corresponding figure of the first group of simulations (i.e. 24.7%).

Table 7. Simulated global land use changes due to the US ethanol production: Off of updated baseline

Changes in US corn ethanol output	Land use changes (hectares)			Distribution of land use changes (%)		
	Forest	Grassland	Crop*	Forest	Grassland	Total*
3.085 BG (2001 to 2006)	-155414	-283921	439349	35.4	64.6	100.0
2.145 BG (2006 to 7 BG)	-107215	-194290	301503	35.6	64.4	100.0
2.000 BG (7 BG to 9 BG)	-98360	-190567	288927	34.0	66.0	100.0
2.000 BG (9 BG to 11 BG)	-102124	-193538	295660	34.5	65.5	100.0
2.000 BG (11 BG to 13 BG)	-104305	-196978	301279	34.6	65.4	100.0
2.000 BG (13 BG to 15 BG)	-105540	-200984	306524	34.4	65.6	100.0
13.23 BG (2001 to 15 BG)	-672959	-1260277	1933242	34.8	65.2	100.0

*The difference between the changes in cropland and the sum of forest and grassland is due to rounding

Group 3: Simulations with crop yield and population growth for the time period of 2006-20015

Some advocates of the US corn ethanol program argue that crop yields will increase in the future such that this increase could eliminate the land use implications of ethanol production. This argument neglects the impacts of the future changes in the demand for crops. Demands for crops could increase in the future due to several factors such as changes in population and income, dietary transition as poorer countries consume more meat, or technological progress. In other words, one cannot examine yield (supply) increases alone; we must also include assumptions about increases in crop demand as well. In the third group of simulations we

examine impacts of changes in crop yields and demand as important items which could determine demand and supply for crops and food products.

For our model simulations we use population growth as a proxy for food demand increase. We assume that population will continue to grow globally during the time period of 2006-2015 after 2006 at the annual growth rate of 2001-2006. We also assume that crop yield will increase uniformly at 1% annually after 2006 in all regions and across all types of crops. While 1% might seem small, it is actually a large number as it is applied in all regions and for all crops. We also assume that the regional demands for forest products will increase according to their annual rates of 2001-2006. We made the latter assumption to maintain the long run pattern in forest products outputs. These simulations also include all the changes incorporated in the baseline simulation of the second group of simulations.

To find the land use impacts of US ethanol program under these assumptions we did simulations with and without US ethanol production off of the updated data base for 2006 (obtained in the second group of simulations) for the time period of 2006-2015 in the presence of population and yield shocks. The global land use implications of the US ethanol plan under these assumptions are shown in appendix C. To understand the land use implications of the US ethanol program under these assumptions we first analyze the land use implications with no US ethanol production. Table 8 indicates land use changes due to the yield and population growth for US, EU, Brazil, and other regions.

Table 8 indicates that after 2006 the cropland areas of US, EU, Brazil, and other regions would fall due to the simultaneous shocks in yield and population growth. This means that yield growth would dominant the demand growth for crops, and therefore the demand for cropland

decreases everywhere. In addition to that, the yield growth contributes to higher levels of food consumption everywhere.

Table 8. Simulated global land use changes due to population and yield growth after 2006 (figures are in 1000 hectares)

Period	Land cover	US	EU	Brazil	Others	World
2006-2007	Forestry	142.8	194.8	430.5	2141.4	2909.5
	Cropland	-162.1	-217.5	-97.3	-2382.6	-2859.5
	Pastureland	19.4	22.7	-333.2	241.2	-50.0
2007-2009	Forestry	380.0	512.8	917.6	6070.3	7880.6
	Cropland	-363.6	-513.7	-232.3	-5940.4	-7050.0
	Pastureland	-16.3	0.9	-685.3	-129.9	-830.6
2009-2011	Forestry	548.3	713.7	1077.5	9085.8	11425.3
	Cropland	-406.4	-623.6	-268.0	-7764.1	-9062.2
	Pastureland	-141.9	-90.1	-809.5	-1321.7	-2363.2
2011-2013	Forestry	736.4	929.7	1287.0	12422.1	15375.2
	Cropland	-452.2	-737.3	-298.5	-9776.0	-11264.0
	Pastureland	-284.2	-192.4	-988.5	-2646.1	-4111.2
2013-2015	Forestry	997.5	1243.9	1610.3	15745.7	19597.5
	Cropland	-522.7	-886.0	-340.6	-11626.9	-13376.2
	Pastureland	-474.8	-358.0	-1269.7	-4118.8	-6221.4

The simulation results indicate that consumption of crops and food products grow faster than population everywhere across the world. This indicates that the yield effect works through two channels: 1) reduction in crop land area needed to satisfy demand, and 2) higher per capita consumption of food. This means that one percent yield improvement will not end with one percent reduction in cropland, even if there is no population growth.

The released croplands are going to forest to support the long run growth in forest products. Note that as mentioned earlier in this group of simulations we assume the global forest sector will continue to grow according to its 2001-2006 growth rate.

With this discussion we now examine impacts of adding biofuel shocks into this picture. In general, the US ethanol program in this group of simulations generate smaller land use

changes compared the results of the second group of simulations. Table 9 shows that under the assumptions of this group of simulations we need 1.5 million hectares of cropland to increase ethanol production from the 2001 level to 15 BGs. This figure is smaller than the corresponding figure obtained from the second group of simulations by 20%. For the earlier time segments after 2006 the size of land requirement is significantly smaller than what we observed in the second group of simulations. For example, in this group of simulations we need only 0.1 hectares of cropland to produce 1000 gallons of ethanol in the time segment of 2006-2007, while the corresponding number obtained from the second group of simulations is about 0.14.

As we move forward towards 2015, the population growth dominants the yield growth in some regions, and the land requirement grows. Table 9 shows that the share of US in land requirement grows at the beginning but it decreases when we move towards 2015.

Table 9. Simulated global land use changes due to the US ethanol production: with yield and population growth after 2006

Changes in US corn ethanol production	Land use changes (hectares)			Distribution of Land Use changes (%)			Hectares per 1000 gallons
	Within US	Other Regions	World	Within US	Other Regions	World	
3.085 BG (2001 to 2006)	119281	320068	439349	27.1	72.9	100.0	0.14
2.145 BG (2006 to 7 BG)	58799	150754	209553	28.1	71.9	100.0	0.10
2.000 BG (7 to 9 BG)	58167	134225	192392	30.2	69.8	100.0	0.10
2.000 BG (9 to 11 BG)	60919	141118	202038	30.2	69.8	100.0	0.10
2.000 BG (11 to 13 BG)	64529	167511	232040	27.8	72.2	100.0	0.12
2.000 BG (13 to 15 BG)	69848	196148	265996	26.3	73.7	100.0	0.13
13.23 BG (2001 to 15 BG)	431544	1109824	1541368	28.0	72.0	100.0	0.12

The distribution of land use changes between forest and pasture land are similar to the second group of simulations. Our assumption on the regional demands for forest products derives this result. It is very important to note that adding income growth or changes in other economic factors into this picture may change the geographical distribution of land use changes or the

distribution of the land requirement for ethanol production between forest and grassland. (Table 10)

Table 10. Simulated global land use changes due to the US ethanol production: With yield and population growth after 2006

Changes in US corn ethanol output	Land use changes (hectares)			Distribution of land use changes (%)		
	Forest	Grassland	Crop*	Forest	Grassland	Total*
3.085 BG (2001 to 2006)	-155414	-283921	439349	35.4	64.6	100.0
2.145 BG (2006 to 7 BG)	-71830	-137724	209553	34.3	65.7	100.0
2.000 BG (7 BG to 9 BG)	-67347	-125070	192392	35.0	65.0	100.0
2.000 BG (9 BG to 11 BG)	-70376	-131670	202038	34.8	65.2	100.0
2.000 BG (11 BG to 13 BG)	-79832	-152216	232040	34.4	65.6	100.0
2.000 BG (13 BG to 15 BG)	-93949	-172051	265996	35.3	64.7	100.0
13.23 BG (2001 to 15 BG)	-538749	-1002651	1541368	35.0	65.0	100.0

*The difference between the changes in cropland and the sum of forest and grassland is due to rounding

4. Land use CO_2 emission factors

We use emissions factors to convert land use changes into the land use CO_2 emissions (LUCE). Land conversions of forest and grassland into crop production releases CO_2 emissions from two sources: 1) direct CO_2 emissions from land conversion and 2) foregone CO_2 sequestration by forests. The direct CO_2 emissions consist of carbon stored in the vegetation and in the soil, which are released when forests or grasslands are cleared and converted into croplands. The forgone carbon sequestration accounts for the amount of carbon that could have been stored from annual forest growth, if land had remained forested. This is the opportunity costs of cleared land in terms of its potential to store carbon.

As mentioned earlier in this report we use the Woods Hole data set[9]. This data set divides the world into 10 homogenous regions, determines distributions of forests and grasslands within each region across different types of vegetation cover, and provides detailed information on the carbon stored in the vegetation and in the soil of forests and grasslands within each region.

[9] This data set, which is taken from the supporting documents of SEA

The Woods Hole data set provides two key carbon figures for each type of land according to its natural vegetation. These figures are carbon stored in the soil and carbon stored in the vegetation. We assume that when a natural vegetation area (either forest or grassland) is converted to cropland, about 25% of the carbon stored in its soil will be released into the atmosphere. In addition, we assume 75% of carbon stored in the forest type vegetation and 100% percent of carbon stored in the grassland vegetation will be released into the atmosphere at the time of land conversion[10]. If more than one type of vegetation is available in an area we calculate the weighted average emissions for that area, where weights are shares of vegetation areas. We calculate emissions factors for forest areas and grasslands, separately. Sensitivity analysis can be conducted on any of the data and assumptions used in this analysis.

Regarding the forgone carbon sequestration we assumed when a natural vegetation area is converted to cropland, it loses its carbon sequestration capacity as long as it is under crop production. Again, if more than one type of land is available we use weighted average of forgone carbon sequestration. We simply add the direct and forgone sequestration in each region. Hence, in each area we have two groups of emissions factors: forest and grassland emission factors. The Woods Hole data set along with emissions factors obtained from this data set are presented in Appendix E. Data in this appendix are calculated based on the assumption that the converted land to crop production will remain under crop production for 30 years[11]. We recognize that the 30 year period is somewhat arbitrary, and we have not considered what changes might occur after that period. Thirty years is about the life of a biofuels facility, so it seems as reasonable an assumption as any.

[10] In essence, we are assuming that 25% of the carbon in wood is stored in buildings, furniture, etc.
[11] To test the sensitivity of carbon emissions factors with respect to the time period of ethanol production, we calculated the land use emissions factors for 50, 80, and 100 years from the Woods Hole data in our earlier report (Tyner, Taheripour, and Baldos, 2009).

At this point it is important to note that some research indicates that conservation tillage practices and enhanced rotation programs can increase carbon sequestration ability of croplands. This means that using advanced technologies in corn production can increase carbon stored in soil (West and Post, 2002). In this paper we ignore impacts of advanced tillage methods on the carbon sequestration ability of cropland.

As we mentioned earlier the Woods Hole data set divides the world into 10 regions. On the other hand this version of the GTAP model divides the world into 19 regions. Table 11 relates each region of GTAP to one of the regions of the Woods Hole data set.

Table 11. GTAP and Woods Hole regions

GTAP Regions	Woods Hole Regions
United States	United States
Canada	Canada
Sub Saharan Africa	Africa
European Union 27 East Europe and Rest of Former Soviet Union Rest of European Countries	Europe
Russia	Former Soviet Union
Brazil Central and Caribbean Americas South and Other Americas	Latin America
Middle Eastern and North Africa	North Africa and Middle East
East Asia Oceania Japan	Pacific Developed
China and Hong Kong India	China/India/Pakistan
Rest of South East Asia Rest of South Asia Malaysia and Indonesia	South and Southeast Asia

We now present regional forest[12] and grassland emissions factors derived from the Woods Hole data set in Table 12. Converting forest areas to cropland in South and South East

[12] Searchinger et al. 2008 calculated forest forgone emissions from carbon uptake by growing forest. Indeed they divided growing forest uptake by the area of total area forest in each ecosystem to determine forgone carbon emissions. We followed this approach to make our results comparable with Searchinger et al. 2008 results.

Asia, China, and India generates the highest CO_2 emissions per hectare of land compared to the rest of the world in the Wood's Hole data. For example, the forest emissions factor in these regions is equal to 23 metric tons of CO_2 per hectare of forest per year, when the duration of ethanol production is 30 years. The lowest emissions factor among forest areas is in Sub Saharan Africa. In this region the forest annual emissions factor is equal to 10.4 metric tons of CO_2 per hectare of forest.

Table 12. GTAP regions and their corresponding CO_2 emissions factors for forest and grassland areas (figures are in annual metric ton CO_2 equivalent per hectare for 30 years corn production time horizon)

Regions	Forest emissions factors	Grassland emission factors
United States	19.6	3.7
Canada	15.3	5.7
Sub Saharan Africa	10.4	1.5
European Union 27 East Europe and Rest of Former Soviet Union Rest of European Countries	18.6	6.6
Russia	14.1	7.0
Brazil Central and Caribbean Americas South and Other Americas	16.1	2.5
Middle Eastern and North Africa	12.2	2.2
East Asia Oceania Japan	13.2	3.5
China and Hong Kong India	23.0	6.6
Rest of South East Asia Rest of South Asia Malaysia and Indonesia	23.0	6.6

The third column of Table 12 shows annual emissions factors for grassland areas derived from the Woods Hole. Figures of this table illustrate that converting grasslands to crop

However, this approach underestimates the magnitude of forgone forest emissions. Growing forest update should be divided by the area of growing forest - not the total area in forest. In addition, for many ecosystem types the Woods Hole database shows zeros for growing forest.

production releases smaller CO_2 emissions compared to deforestation. The highest regional grassland annual emissions factor, derived from the Woods Hole data set, is Russia (with 7 metric tons CO_2 per hectare per year), and the lowest is Sub Saharan Africa (with 2.2 metric tons CO_2 per hectare per year).

5. Estimated land use CO_2 emissions due to the US ethanol production

We now combine simulated land use changes due to US ethanol production with the CO_2 release emissions factors. This is a straight forward process. Suppose ΔLF_{rj} (see Tables 2, 6, 9) is the size of change in land type j (for j = forest and grassland) in region r due to X gallons of increase in the US ethanol production. In addition, suppose that the annual CO_2 emissions factor for land type j in region r for a 30 year ethanol production is about Frj (see Table 12). Then the global annual CO_2 emissions due to producing x gallons of ethanol per year in the US will be equal to:

(1) $$LUE_W = \sum_r \sum_j \Delta LF_{rj} \cdot F_{rj} \quad .$$

Using this approach we calculated CO_2 emissions for all land use simulation scenarios (Three groups of simulations and 6 time segments) and for all emissions factors derived from the Woods Hole data sets. Once we have emissions, we can calculate the marginal and average land use emissions due to production of each gallon of pure ethanol (E100) for all groups of simulations examined in this paper. For example, Table 13 shows how we calculated the marginal land use emissions due to producing each gallon of E100 for the 13 to 15 BGs for the first group of our simulations.

Table 13. Estimated marginal land use emissions per gallon of E100 for 13 to 15 billion gallons simulation (30 year pay off method)

Total 30 year emissions from land use changes (million metric tons)	110.77
Change in ethanol production (million gallons) per year	2000
Emissions (metric tons per gallon-year of ethanol)	0.0554
Emissions (grams per gallon-year of ethanol)	55386
One year marginal emissions (grams per gallon of ethanol)	1846

The value of 110.77 million metric tons of emissions presented in this table is obtained by multiplying regional forest and grassland changes due to an increase in ethanol production from 13 to 15 BGs (see appendix C) by their corresponding Woods Hole annual emissions factors presented in the second and third columns of Table 12 and then summed over regions. The result of this calculation is multiplied by 30 to present the magnitude of total emissions over 30 years. One can follow the rest of example through table 13. We now present land use emissions for all groups of simulations discussed earlier in this report.

Land use emissions for the first group of simulations

Table 14 represents marginal and average land use emissions obtained from simulations off of the 2001 database. This table indicates that marginal emissions are increasing in ethanol production. For example, while an increase in ethanol production from 7 BGs to 9 BGs generates 1687 grams CO_2 emissions per gallon of ethanol, moving from 9 BGs to 11BG causes 1745 grams CO_2 per gallon. When ethanol production reaches 15 BGs, then each additional gallon of ethanol generates 1846 grams of CO_2. Table 14 indicates that average emissions are increasing in ethanol production as well. This table shows that during the time period of 2001-6 on average each gallon of US ethanol was generating 1477 grams CO_2. However, if ethanol production reaches 15 BGs, then on average each gallon of ethanol generates 1676 grams of emissions. It is

important to note that in this group of simulations about 61% of emissions come from deforestation and 39% come from converting grasslands into crop production.

Table 14. Annual marginal and average estimated land use emissions due to the US ethanol production: Obtained from the simulations off of the 2001 database

Time Segment	Marginal Emissions (grams CO_2 per gallon of ethanol)				Average emissions (grams CO_2 per gallon of ethanol)			
	Changes in ethanol production	Forest	Grasslands	TOTAL	Total ethanol production	Forests	Grasslands	TOTAL
2001-6	3.085	886	590	1477	3.085	886	590	1477
2006-7	2.145	990	628	1619	5.23	929	606	1535
2007-9	2.000	1033	654	1687	7.23	958	619	1577
2009-11	2.000	1067	677	1745	9.23	982	632	1613
2011-13	2.000	1097	701	1797	11.23	1002	644	1646
2013-15	2.000	1122	724	1846	13.23	1020	656	1676

Note that in this paper we ignored impacts of the first 1.77 billion gallons of ethanol on the average land use changes per gallon of ethanol production. Incorporating land uses changes due to the first 1.77 billion gallons of ethanol will moderately reduce the average emissions per gallon of ethanol.

Land use emissions obtained from this group of simulations are smaller than our earlier estimates for land use emissions. For example, as shown in table 14, on average each gallon of US generates 1676 grams emissions. The corresponding number in our earlier report was about 2210 grams emissions. This shows about 16.5% reduction emissions per gallon of ethanol. This is due to using the new regional ETAs and incorporating cropland pasture into the picture.

Land use emissions for the second group of simulations

Table 15 presents the marginal and average emissions for the second group of simulations, where we calculate land use changes according to the updated baseline for 2001-6.

Emissions obtained from second group of simulations follow the pattern of the first group. However, their magnitudes are smaller than the first group.

Table 15. Annual marginal and average estimated land use emissions due to the US ethanol production: Obtained from the simulations off of the updated 2006 database

Time Segment	Marginal emissions (grams CO_2 per gallon of ethanol)				Average emissions (grams CO_2 per gallon of ethanol)			
	Changes in ethanol production	Forest	Grasslands	TOTAL	Total ethanol production	Forests	Grasslands	TOTAL
2001-6	3.085	1003	412	1414	3.085	1003	412	1414
2006-7	2.145	1026	349	1376	5.23	1012	386	1399
2007-9	2.000	1002	370	1372	7.23	1009	382	1391
2009-11	2.000	1028	377	1406	9.23	1014	381	1394
2011-13	2.000	1043	385	1429	11.23	1019	382	1400
2013-15	2.000	1052	395	1446	13.23	1024	384	1407

As shown in table 15, when the US ethanol production reaches to 15 BGs of ethanol each additional gallon of ethanol generates about 1446 grams of emissions. At this level of ethanol production, on average each gallon of ethanol causes 1407 grams of CO_2 emissions. These figures are smaller than the corresponding figures of the first group of simulations by 21.7% and 16%. These reductions are due to yield improvement during the time period of 2001-2006. As noted earlier in this time period yield has improved in many regions faster than the demand for crops for food. It is important to note that in this group of simulations more than 70% of emissions come from deforestation and the rest comes from converting grasslands into crop production.

Land use emissions for the third group of simulations

Table 16 shows the marginal and average land use emission for the third group of simulations, where we calculate land use changes according to the simulations with the updated 2001-06 database and population, yield, and forest product growth.

Table 16. Annual marginal and average estimated land use emissions due to the US ethanol production: Obtained from the simulations off of the updated 2006 database and with population and yield growth after 2006

Time Segment	Marginal emissions (grams CO_2 per gallon of ethanol)				Average emissions (grams CO_2 per gallon of ethanol)			
	Changes in ethanol production	Forest	Grasslands	TOTAL	Total ethanol production	Forests	Grasslands	TOTAL
2001-6	3.085	1003	412	1414	3.085	1003	412	1414
2006-7	2.145	674	305	978	5.23	868	368	1236
2007-9	2.000	565	372	937	7.23	784	369	1153
2009-11	2.000	469	477	946	9.23	716	392	1108
2011-13	2.000	433	619	1051	11.23	665	433	1098
2013-15	2.000	480	736	1217	13.23	637	479	1116

As shown in table 16, in this case during the time period of 2006-2015 the marginal emissions grow when the population growth dominates the yield growth. For example, an additional gallon of ethanol produces about 978 grams emissions in the time segment of 2006-7, while each gallon of additional ethanol causes 1217 grams emissions in the time segment of 2013-15. In this group of simulations on average each gallon of ethanol generates about 1116 grams emissions. This figure is smaller than the corresponding figure obtained from the second group of simulations by about 21 percent.

6. Final analysis

We now compare the land use emissions obtained from the three groups of simulations with the results of SEA. Table 17 shows lower emissions due to indirect land use change when we incorporate all economic and demographic and yield growth into account in the third group

of simulations. The average value of the third group of simulations is about 13% of the original SEA result. The results of the first and the second groups of simulations are about 21% and 16.4% of SEA.

Table 17. Estimated land use change emissions due to U.S. ethanol production (Comparing GTAP and Searchinger et al. (2008) results)

Searchinger et al. (2008)	Total Emissions for 30 years (million metric tons)	3801
	Change in ethanol production (billion liters of ethanol)	55.92
	Total emissions for 30 years (grams per liter)	67972
	Liters per gallon	3.785
	Total emissions for 30 years (grams per gallon of ethanol)	257302
	One year emissions (grams per gallon of ethanol)	8577
GTAP results off of 2001 database	One year average emissions (gram per gallon of ethanol)	1676
	One year marginal emissions (gram per gallon of ethanol)	1846
GTAP results off of 2006 database	One year average emissions (gram per gallon of ethanol)	1407
	One year marginal emissions (gram per gallon of ethanol)	1446
GTAP results off of 2006 plus population & yield growth	One year average emissions (gram per gallon of ethanol)	1116
	One year marginal emissions (gram per gallon of ethanol)	1217

Total emissions from production and consumption of ethanol

Table 18 contains the estimated well-to-wheel ethanol emissions for the marginal and average land use changes for the three groups of simulations[13]. For the first group of simulations production and consumption of each gallon of ethanol (E100) on average generates about 6800 grams of GHGs emissions. In this case about 24.6% of released emissions are related to land use changes. When we incorporate changes in population and other factors, each gallon of ethanol (E100) on average causes about 6531 grams of GHGs emissions. In this case about 21.5% of released emissions are related to land use changes. Finally, in the third group, when we take into account the population and yield growth after 2006, then production and consumption of each

[13] In this report the direct marginal GHG emissions (i.e. non-land emissions) of ethanol for the post 2006 are taken from 100% dry mill.

gallon of ethanol (E100) generates about 6240 grams of emissions. In the third case, about 17.9% of released emissions are related to land use change.

Table 18 indicates well to wheel ethanol emissions expressed as grams/gal of ethanol and in grams per Megajoule (MJ). For the first, second, and third groups of simulations production and consumption of each gallon of ethanol (E100) on average generates about 84.4 g/MJ, 81.1 g/MJ, 77.5 g/MJ emissions, respectively.

Table 18. Estimated annual well-to wheel ethanol emissions for marginal and average land use changes

Description		Land use emissions (grams/gal)	Land use emissions (grams/MJ)	Well-to-wheel emissions without land use[a] (grams/gal)	Well-to-wheel emissions plus land use (grams/gal)	Well-to-wheel emissions plus land use (grams/MJ)[b]
Simulations Off of 2001	Marginal	1846	22.9	5100	6946	86.3
	Average	1676	20.8	5124	6800	84.4
Simulations Off of 2006	Marginal	1446	18.0	5100	6546	81.3
	Average	1407	17.5	5124	6531	81.1
Simulations Off of 2006 Plus population & yield growth	Marginal	1217	15.1	5100	6317	78.4
	Average	1116	13.9	5124	6240	77.5

[a]From GREET simulations. We used the default values in GREET version 1.3c for 2015 for the simulations. The marginal and average differ for ethanol direct emissions because the fraction that is wet versus dry milling decreases over time yielding slightly lower direct emissions for the marginal case.
[b]Low heating values of gasoline and ethanol are: 116090 BTU/gal and 76330 BTU/gal.

Finally, Table 19 compares total emissions of E100 obtained from the three groups of simulations with the emissions of conventional gasoline. This table indicates that ethanol production induces lower emissions compared to conventional gasoline for all groups of simulations. For example, total GHGs emissions due to production and consumption of E100 (including land use emissions) obtained from the first group of simulations are about 10342 grams per gallon of gasoline equivalent for the average land use changes. This figure is about

90.4% of the emissions due to production and consumption of conventional gasoline. When we use the updated 2006 database, total estimated GHGs emissions due to production and consumption of E100 are about 9933 grams per gallon of gasoline equivalent for the average land use changes. This figure is 86.9% of the emissions due to production and consumption of conventional gasoline. Finally, when we use the updated data base, and we assume population and yield increase after 2006, then total estimated emissions for E100 are 9490 grams per gallon of gasoline equivalent for the average land use changes. In this case the E100 emission estimate is about 83.0% of emissions associated with conventional gasoline. Table 19 presents emissions of ethanol and gasoline in grams per gallon of gasoline equivalent and per MJ.

Table 19. Estimated well-to-wheel ethanol and gasoline emissions for average land use changes

Description		Emissions in grams per gallon of gasoline equivalent			Emissions in grams/MJ		
		Ethanol	Gasoline	Ethanol vs gasoline (percent)	Ethanol	Gasoline	Ethanol vs gasoline (percent)
Simulations Off of 2001	Marginal	10564	11428	92.4	86.3	93.3	92.2
	Average	10342	11428	90.5	84.4	93.3	90.5
Simulations Off of 2006	Marginal	9956	11428	87.1	81.3	93.3	87.1
	Average	9933	11428	86.9	81.1	93.3	86.9
Simulations Off of 2006	Marginal	9608	11428	84.1	78.4	93.3	84.1
	Average	9490	11428	83.0	77.5	93.3	83.0

Since the third group simulations takes into account changes in population, crop yields, economic growth, and growth in primary inputs during the time period of 2001-2006 and after that assumes that population and yield growth will continue, the emissions obtained from this group of simulations are lower than the other cases. However, the results are derived from our assumptions, in particular for the time period of 2006-2015. Any change in these assumptions

could alter the results. In other words, we have assumed 1 percent global growth in yields for all crops and 2001-06 population growth through 2015. Changes in these assumptions would alter the numerical results.

7. Conclusions

The overarching objective of this research has been to estimate the global land use changes induced by US corn ethanol programs and in doing so to closely examine some of the critical issues that have been overlooked in some prior studies. It is a very controversial topic. Some argue it is impossible to measure such changes. Others argue that failure to measure the land use changes and the consequent GHG emissions would lead us to incorrect policy conclusions. After working on this topic for over two years, we come out between these extremes. First, with almost a third of the US corn crop today going to ethanol, it is simply not credible to argue that there are no land use change implications of corn ethanol. The valid question to ask is to what extent land use changes would occur. Second, our experience with modeling, data, and parameter estimation and assumptions leads us to conclude that one cannot escape the conclusion that modeling land use change is quite uncertain. Of course, all economic modeling is uncertain, but it is important to point out that we are dealing with a relatively wide range of estimation differences. The estimation range depends on what is being simulated, as will be seen below.

Over the two plus years we have working on this topic, we have made numerous improvements in the models used for the analysis. These improvements are spelled out in the text above and in the appendices. We have better data on land productivity and on cropland pasture and CRP lands, and these data and associated parameters are now in the model. We have improved the treatment of the livestock and livestock feed sectors. Similarly, these changes are

reflected in the current version of the model. We have amassed data on crop yields and many other variables for every region of the world and used much of that data in our analysis and model calibration. These data and model improvements have significantly improved the analysis and model results.

Table 20 provides a convenient summary of the evolution of some of our results over the different versions of the model and data. The third column replicates the summary results from our January 2009 draft paper before all the model changes described were implemented. The January 2009 results are provided only for reference, so our comparisons will be based on the three simulations reported in this paper. The fourth column is with all the model improvements and the 2001 data base. The fifth column is with the baseline updated to 2006 as described above. The last column is both with the updated baseline to 2006 and the assumed growth in demand and supply as described above.

Table 20. Summary of the different modeling results

Result	Units	Original Jan. 09 estimates	Model improvements with 2001 data base	Baseline updated to 2006	Updated baseline and growth in demand and yield
Land needed for ethanol	Ha./1000 gal.	0.27	0.22	0.15	0.12
Distribution of land use change between forest and pasture	%forest/%pasture	23/77	25/75	35/65	35/65
Distribution of land use change between U.S. and rest of world	%US/%Others	35/65	34/66	25/75	28/72
Average emissions of 15 bil. gal. program	Grams CO_2/gal. of ethanol	1931	1676	1407	1116
% of Searchinger, et al.	%	22.5	19.5	16.4	13.0
Emissions per gallon gasoline eq.	Grams CO_2/gal.	10564	10342	9933	9490
Emissions per MJ	Grams $C0_2$/MJ	86.3	84.4	81.1	77.5
Total ethanol emissions as % of gasoline	%	92.4	90.5	86.9	83.0

In some cases, the results are fairly stable regardless of the simulation. For example, the percentage of land that comes from forest ranges between 25 and 35 percent depending on the model and assumptions being used. Similarly, the fraction of land use change that occurs in the U.S. ranges between 25 and 34 percent. However, the land needed to meet the ethanol mandate ranges between 0.12 and 0.22 hectares/1000 gallons, which is a fairly wide range. The ethanol CO_2 emissions per gallon range between 1116 and 1676, also a fairly large range. However, the total emissions per MJ range between 77.5 g/MJ and 84.4 g/MJ, a small range. The reason for the small range in this case is that the direct ethanol emissions are assumed to be constant, so the land use emissions are being added to a constant level of direct emissions making the variability in total emissions per mile smaller.

Ethanol emissions as a fraction of gasoline emissions range between 83.0 and 90.5 percent. From these results, we feel confident that corn ethanol would meet a 10 percent savings standard. On the other hand, the results suggest that corn ethanol would not meet a 20 percent emissions reduction standard. However, we cannot conclude that corn ethanol would not meet a 20 percent standard given the inherent uncertainty in the analysis, and potential improvement in direct emissions associated with corn farming and ethanol production. In a recent analysis including uncertainty in GHG estimation using an earlier version of GTAP-BIO, Hertel et al. (2010) concluded that the corn ethanol induced emissions from land use change range between 2 and 51 g/MJ. Our estimate for the last case is 14 g/MJ. This large range taken from another study using similar approaches clearly illustrates the uncertainty inherent in this analysis. It also concludes that zero is not within the error bounds. In other words, we know land use change induced emissions are not zero, but measuring them with high precision is not yet possible.

8. Limitations and future research

As indicated above, analysis such as that undertaken here is very complex and is limited by data availability, validity of parameters, and other modeling constraints. Economic models, like other models, are abstractions from reality. They can never perfectly depict all the forces and drivers of changes in an economy. However, the basic model used for this analysis, GTAP, has withstood the test of time and peer review. Hundreds of peer reviewed articles have been published using the GTAP data base and analytical framework. In this project, we have made many changes in the model and data base to improve its usefulness for evaluating the land use change impacts of large scale biofuels programs. Yet, uncertainties remain. In this paper, we have described the evolution of the modeling and analysis and present openly the evolution of the results. Like other GTAP model versions, once it has been subjected to peer review, this model version will be available to others in the GTAP community to use in their analyses. We believe quite strongly that analysis of this type must be done with models and data bases that are available to others. Replicability and innovation are critical factors for progress in science. They also are important for credibility in policy analysis.

Some of the important topics for future research are as follows:

- More sensitivity on prospective growth in crop demand and supply by region and AEZ. The future growth in demand and supply of agricultural commodities, particularly coarse grains, are critical determinants of the impacts of biofuel programs. If global income and population growth and dietary transition lead to greater growth in demand for coarse grains than in supply, the impacts of biofuels mandates would be greater. On the other hand, if new technologies and broader adoption of these technologies lead to greater growth in supply, then the impacts of biofuels mandates would be reduced.

- Research is needed on the impacts on food and feed systems induced by biofuels under real world conditions of weather variability. Under binding mandates such as the Renewable Fuel Standard, demand is quite inelastic, which would lead to greater commodity price variability in the event of weather shocks such as drought.
- Improved data and information on land use and land cover change could be used in the future to improve model parameters and perhaps the model structure. We are certainly open to considering new information in this domain in the future.
- In this version of the model, substantial improvements in modeling and parameters for livestock production and use of feedstuffs including DDGS have been made. Nonetheless, as the markets evolve we will learn more about the functioning of these markets as feed users adapt to the new animal feeding realities.
- In general, we will need to update the model in many ways as new versions of the GTAP data base are released. This is an on-going process for GTAP. The new version of the GTAP data base is version 7, so constant quality improvement has been part of business as usual since the launch of GTAP in 1994.
- In this research we relied on Woods Hole data set to derive land use carbon emissions. This data set provides limited information on forgone carbon sequestration due to deforestation. This is a major deficiency. We have developed a set of land use emissions using the TEM model at the AEZ for all GTAP regions. However, they have not yet been verified and subjected to peer review, so they are not used in this analysis.

Our primary focus now is to incorporate cellulosic feedstocks into GTAP and to find better ways of getting greater sub-regional specificity in our analysis. We are now working with partners, including Argonne, to accomplish these objectives.

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Appendix A

Regional Land Conversion Factors (ETA parameters)
Productivity of new cropland versus productivity of existing cropland

Appendix A: Land Conversion Factors

In the GTAP-BIO-ADV model the parameter ETA, which shows productivity of new cropland versus productivity of exiting cropland, plays an important role in determining the land use impacts of biofuel production. In our past simulations for biofuel analyses we usually assumed that ETA=0.66 for all regions across the world. Indeed, with this setup we assumed that productivity of one unit (let say one acre) of new croplands is equal to 2/3 of the productivity of one acre of existing croplands, all across the world. In this report we leave this assumption and we apply regional ETAs at the AEZ level. The regional ETAs are obtained from a process-based biogeochemistry model (Terrestrial Ecosystem Model (TEM)) along with spatially referenced information on climate, elevation, soils, and vegetation land use data. The new regional ETAs are varying across the world and among AEZs. In this appendix, we first explain the role of ETA in the GTAP-BIO-ADV model. Then we briefly introduce the TEM model and its data sources. Finally we explain derivations of the regional ETA parameters along with the results.

Role of ETA in the land use module

As we mentioned above ETA measures the productivity of the new cropland versus the productivity of existing cropland. To avoid confusion we define these two types of land:

Existing cropland: Is defined as a land which has been cultivated and used for crop production in the past. GTAP classifies these lands under the title of crop cover.

New cropland: Is defined as natural land (could be either forest or pasture land) that will be converted to cropland due to the need for expansion in the demand for crops.

We now use an example to explain the role of ETA in the GTAP-BIO-ADV model. Suppose that we want to expand production of corn in region *A* by 600 bushels and also suppose

that this region only produces corn. In addition, suppose that the corn yield of the existing cropland is about 150 bushels/acre. So the question is how much land we need to produce 600 more bushels of corn? The answer is that it depends on the productivity of land that we want to bring into crop production. Suppose that region *A* has a piece of forest which can be converted to crop production and that ETA=2/3=0.66. With these assumptions the GTAP-BIO-ADV model will calculate that in region *A* we need 6 acres of land to meet the target. Because it assumes that the yield of the new cropland is about 100 bushels per acre. Now if we assume that ETA=1, (i.e. the productivity of the new and existing cropland are equal) then we need only 4 acres to satisfy the target for corn production. This example highlights the role of ETA in GATP-BIO-ADV model.

In fact, in GTAP we have a solid and reliable database which provides productivity measures for existing croplands for all regions across the world by AEZ. However, we do not have information on the productivity of new cropland, and there are large uncertainties in predicting future productivity of existing cropland in different parts of the world. So far we used parameter ETA=0.66, based on empirical evidence from US land use and consulting experts on the productivity of the new cropland. In this report we use the TEM model along with spatially referenced information on climate, elevation, soils, and vegetation land use data to determine productivity of new cropland versus the existing cropland at the AEZ level in each region. To accomplish this task using the TEM model we calculate the Net Primary Production, as a proxy for productivity, at 0.5° x 0.5° (latitude by longitude) spatial resolution for all grid cells across the world. In this calculation we assume that all grid cells are producing a generic C4 crop. Then we use this information to derive the land conversion factors at the AEZ level for each region of

GTAP. The next section introduces the TEM model and its calculation steps along with the data used in calculating NPPs. Then we discuss the conversion of NPPs to the land conversion factor.

TEM model

We use a process-based biogeochemistry model, the TEM (Zhuang et al., 2003) to estimate NPP for each 0.5° x 0.5° (longitude and latitude) of the global terrestrial ecosystems. TEM uses spatially referenced information on climate, elevation, soils, and vegetation to make monthly estimates of C and N fluxes and pool sizes of the terrestrial biosphere. In TEM, the net ecosystem exchange of CO_2 between the land ecosystems and atmosphere is calculated as the difference between the uptake of atmospheric CO_2 associated with photosynthesis (i.e., gross primary production or GPP) and the release of CO_2 through autotrophic respiration (R_A), heterotrophic respiration (R_H) associated with decomposition of organic matter. The fluxes GPP, R_A and R_H are influenced by changes in atmospheric CO_2, climate variability and change, and the freeze-thaw status of the soil. The following figure represents this model and its major components.

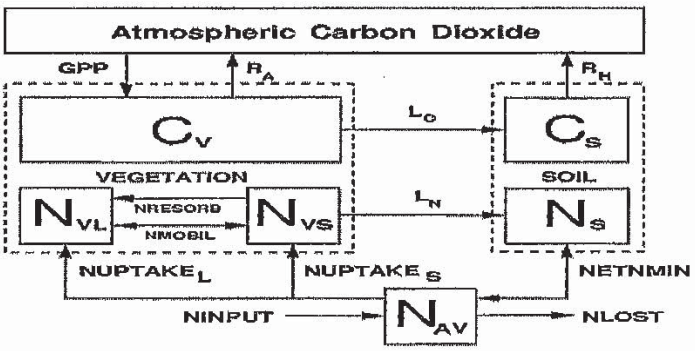


Figure A1. The Terrestrial Ecosystem Model

The model has been extensively used to evaluate C dynamics in northern high latitudes and the globe (e.g., Euskirchen *et al* 2006, Balshi *et al* 2007; Zhuang et al., 2003; Melillo et al.,

1993; McGuire et al., 2001). Its structure, algorithm, parameterization, calibration and performance have been well documented.

Parameters in TEM may be specific to different vegetation types, specific to different soil textures, or constant for all vegetation types and soil textures. Most of the parameters in TEM are assigned values derived from the literature, but some parameters are calibrated to the carbon and nitrogen pools and fluxes of intensively studied sites (see Raich et al., 1991 and McGuire et al., 1992 for details). In this paper the model is calibrated for generic C4 crops. The pools and fluxes of ecosystem carbon and nitrogen of these crop ecosystems are shown in table A1.

Table A1. Carbon and nitrogen pools and fluxes used for a generic parameterization

Variable	Values* for C4	Source and Comments
C_v	649	Evrendilek[2004]
N_v	9.9	Evrendilek[2004]
C_s	3071.5	Evrendilek[2004]
N_s	307.1	Evrendilek[2004]
N_{av}	2.64	Based on 0.86%, the mean N_{av}:N_s ratio
GPP	649	Evrendilek[2004]
NPP	296.6	Evrendilek[2004]
NPPSAT	296.6	Evrendilek[2004]
NUPTAKE	3.98	Calculated from NPP_n, 75%NPP_n=NUPTAKE.

*Units for annual gross primary production (GPP), net primary production (NPP), and NPPSAT are g C $m^{-2}yr^{-1}$. Units for vegetation C (C_v) and soil C (C_s) are g C m^{-2}. Units for vegetation N (N_v), soil N (N_s), and inorganic N (N_{av}) are g N m^{-2}. Units for annual N uptake by vegetation (NUPTAKE) are g N m^{-2} yr^{-1}.

Input data sets

To apply TEM to make spatially and temporally explicit estimates of ecosystem carbon storage and net primary production in this study, we use the same input data sets as were used in Zhuang et al., (2003). These input data sets are important for directly affecting processes in the model (e.g., the effects of soil temperature on heterotrophic respiration) and for defining the parameters that are specific to vegetation types and soil textures. We use a potential vegetation

data set similar to that described in Melillo et al. (1993) to run the model to equilibrium prior to driving the model with transient changes in atmospheric CO_2 and climate. Soil texture and elevation do not vary in our simulations. The transient historical atmospheric CO_2 concentrations are used. The data sets describing historical changes in monthly air temperature and precipitation are gridded at 0.5° x 0.5° spatial resolution for our simulations (Zhuang et al., 2003).

Global simulations

To run TEM for the globe, we use the data of atmosphere, vegetation, soil texture, and elevation at 0.5° latitude x 0.5° longitude resolution from 1900 to 2000. For the simulations of C4 crops, we assume that each grid cell was replaced with the generic C4 crop and keep the information of soils, elevation and climate as the same as the simulation for natural ecosystems. For each grid cell, we first run TEM to equilibrium for an undisturbed ecosystem using the long-term averaged monthly climate and CO_2 concentrations from 1900 to 2000. We then run the model for 150 years with the climate from 1900 to 1949 to account for the influence of inter-annual climate variability on the initial conditions of the undisturbed ecosystem. We then run the model with transient monthly climate data from 1900 to 2000. The simulated NPP for C4 crop simulations of the year 2000 are used for this analysis.

Using NPP data to obtain ETA

We use the NPP data as a proxy for yield to calculate the regional land conversion factors by AEZ. In this process first we matched the results from TEM with our land database to assign AEZs to all grid cells across the world. Then we imposed several restrictions to drop lands which are not good for crop production. In particular, we dropped the grid cells with the following types of land cover:

- ALPINE_TUNDRA_&_POLAR_DESERT
- FORESTED_BOREAL_WETLANDS
- NON-FORESTED_BOREAL_WETLANDS
- TEMPERATE_FORESTED_WETLANDS
- XERIC_SHRUBLANDS
- TROPICAL_FORESTED_WETLANDS
- DESERTS
- TROPICAL_NON-FORESTED_WETLANDS
- TROPICAL_NON-FORESTED_FLOODPL
- TEMPERATE_NON-FORESTED_WETLAND
- TEMPERATE_FORESTED_FLOODPLAINS
- TEMPERATE_NON-FORESTED_FLOODPL

In addition we dropped all grid cells with cells with median of terrain slopes greater than or equal 5%. We dropped these because they are not appropriate for crop production. Then we used the cleaned database to derive the land conversion factors.

To explain the derivation process first we analyze our data for two sample regions: US AEZ10 and Brazil AEZ4. The following two graphs (figures A2 and A3) represent the shares of available and converted natural grasslands in these two sample areas. In each graph we classified the land into 6 groups of productivities (NPPs). Figure A2 indicates that in this AEZ a big portion of the natural grass land is already converted to crop production. A small amount of grassland is available to be converted to crop production in this AEZ. However, the available land is distributed across all productivity groups. Note that the AEZ10 of the US covers a large area with relatively different land qualities, weather conditions and length of growing periods between 180 to 240 days.

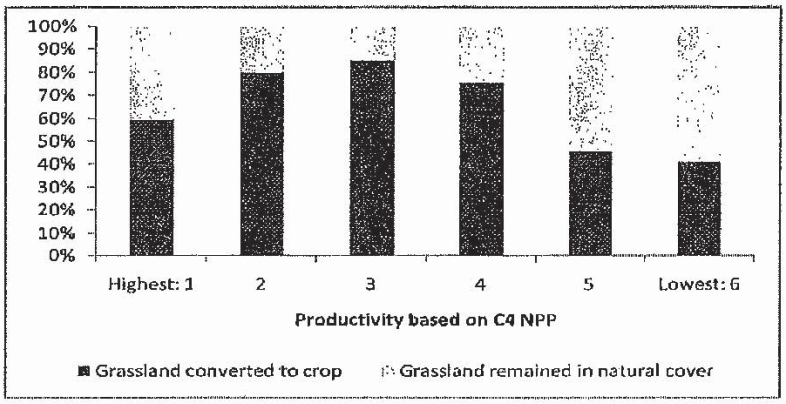


Figure A2. Availability of grassland suitable for crop production in US-AEZ10

Now consider figure A3 which indicates that in the Brazil AEZ4 there are lots of grassland remained in natural cover and only a small portion of grassland in this AEZ has been converted to crop production. In this AEZ available land is distributed across all productivity groups as well.

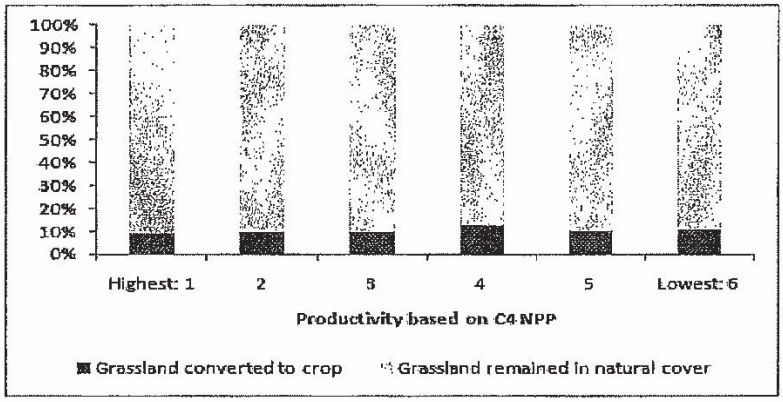


Figure A3. Availability of grassland suitable for crop production in Brazil-AEZ4

Now consider another aspect of the NPP data in these two AEZs. Figure A4 compares the average productivity of grassland converted to crop production in the past with the productivities of all grassland parcels that remained in natural cover in US AEZ10. In this figure grid cells are sorted according to their productivity. So when we move from left side to the right side of the

horizontal axis, we move from grid cells with higher productivities to the grid cells with lower productivities.

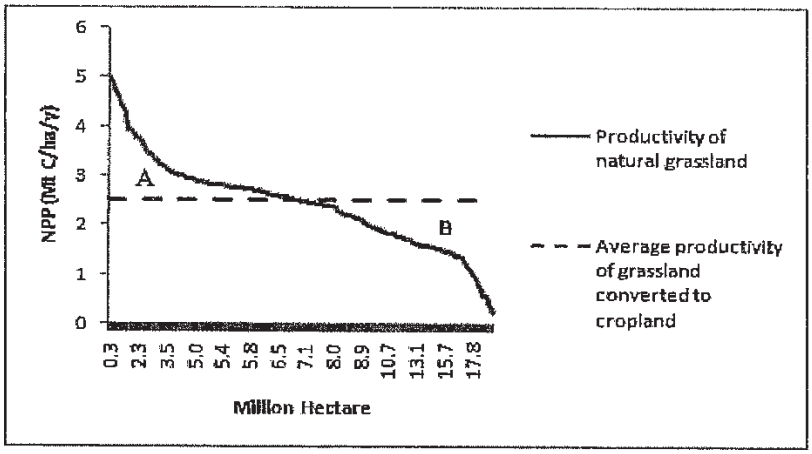


Figure A4. Average and marginal productivities in US AEZ10 for grassland

The ratio of the area A in this graph (area below the productivity of grassland curve and above the average productivity of grassland converted to cropland horizontal line) over the area B (area above the blue curve and below the red line) provides us a land conversion factor for this type of land in this AEZ. All of the land pixels in area A represent pixels with productivity (for C4) higher than the average productivity of existing cropland (the straight line). All of the pixels in B have productivity less than the average cropland. So area A over area B shows average productivity of new land versus average productivity of existing cropland. The assumption then is that the marginal unit of land has this productivity. Figure A5 provides the same information for Brazil AEZ4.

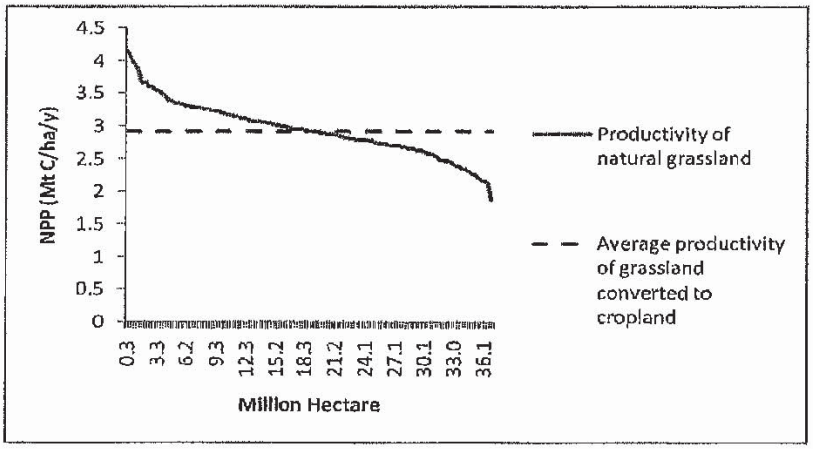


Figure A5. Average and marginal productivities in Brazil AEZ4 for grassland

While we are able to derive the conversion factors for all types of land cover we pooled all land types in each AEZ in each region and we defined the geographical land conversion factors at the AEZ level. It is important to point out that the model does not take into account irrigation. However, in real world in some areas lands are under crop production with irrigation. For this reason we dropped the productivity of all natural land by 10% and we assumed no land conversion factor greater than 1. The results of these calculations are shown in table A2. In this table zero means no land is available and 1 shows that the marginal and average productivities are equal. Table A2 indicates that the US land conversion factors range from 0.51 to 1, depending on the AEZ. Our earlier value for the land conversion factor (i.e. ETA=0.66) falls within this range. However, Table A2 shows that the Brazil land conversion factors range from 0.89 to 1, and most of them are around 0.9. This means that our earlier land conversion factor was underestimating the marginal productivity of land in Brazil. While we apply these land conversion factors in this report we will continue to improve our results in the future.

Table A2. Regional land conversion factors obtained from NPP data for a generic C4 crop[1]

AEZ[2]\Region[3]	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17	R18	R19
1	0.00	0.00	0.91	0.00	0.00	0.00	0.93	1.00	0.95	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.68	0.61	1.00
2	0.00	0.00	0.92	0.00	0.00	0.00	0.89	1.00	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	1.00	1.00
3	0.00	0.00	0.93	0.00	0.00	0.00	0.86	1.00	0.90	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.89	0.74
4	0.00	1.00	0.89	0.00	0.00	1.00	0.93	1.00	0.88	0.00	0.88	0.89	1.00	0.00	0.00	0.00	0.86	0.92	0.92
5	0.00	0.00	0.93	0.00	0.00	0.90	0.98	0.88	0.90	0.00	0.90	0.91	0.98	0.00	0.00	0.00	0.00	1.00	0.96
6	0.00	0.00	0.91	0.00	0.00	0.88	0.98	0.97	0.85	0.00	0.88	0.95	0.78	0.00	0.00	0.00	0.00	1.00	0.88
7	0.73	0.00	0.00	0.89	0.00	0.80	0.90	0.59	1.00	1.00	0.00	0.00	0.43	1.00	0.98	0.00	0.46	0.80	0.65
8	0.71	0.90	0.00	0.91	0.00	1.00	0.71	0.72	0.90	1.00	0.00	0.00	0.60	0.84	0.84	0.00	0.71	0.79	0.86
9	1.00	1.00	0.00	0.85	1.00	0.98	0.88	1.00	0.91	1.00	0.00	0.00	1.00	0.94	0.82	0.00	0.77	0.84	0.93
10	0.93	0.96	0.88	0.88	0.96	0.84	1.00	0.89	1.00	0.93	0.00	1.00	0.92	0.89	0.89	0.87	0.98	0.88	0.92
11	0.96	0.83	1.00	1.00	0.94	0.95	0.90	1.00	0.87	0.84	0.00	1.00	0.79	0.89	1.00	0.00	0.00	0.77	0.96
12	0.89	0.86	0.91	0.00	0.95	0.92	0.90	1.00	0.84	0.00	0.00	1.00	1.00	0.00	0.89	0.00	0.00	1.00	0.98
13	0.92	1.00	0.00	0.55	0.00	1.00	1.00	0.00	1.00	1.00	0.00	0.00	1.00	0.63	0.97	0.00	0.00	0.00	0.00
14	0.51	0.89	0.00	0.80	0.00	0.92	1.00	0.00	1.00	1.00	0.00	0.00	1.00	0.90	1.00	0.95	0.00	0.00	0.00
15	0.71	0.90	0.00	0.83	1.00	1.00	1.00	0.00	0.64	1.00	0.00	1.00	1.00	0.90	1.00	0.87	0.00	0.00	1.00
16	1.00	0.89	0.00	1.00	0.00	1.00	1.00	0.00	0.92	0.00	0.00	1.00	1.00	0.85	1.00	1.00	0.00	0.00	1.00
17	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

1 In this table zero means no land is available and 1 means that the marginal and average productivities are equal.

2 Rows are AEZs from AEZ1 to AEZ18.

3 Columns are regions and regions are listed in Appendix B.

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Appendix B
Lists of Commodities, Industries, and Regions

Table B 1. List of industries and commodities in the new model

Industry	Commodity	Description	Name in the GTAP_BIOB
Paddy_Rice	Paddy_Rice	Paddy rice	Pdr
Wheat	Wheat	Wheat	Wht
CrGrains	CrGrains	Cereal grains	Gro
Oilseeds	Oilseeds	Oil seeds	Osd
OthAgri	OthAgri	Other agriculture goods	ocr, pfb, v_f
Sugarcane	Sugarcane	Sugar cane and sugar beet	c-b
DairyFarms	DairyFarms	Dairy Products	Rmk
Ruminant	Ruminant	Cattle & ruminant meat production and	Ctl, wol
NonRum	Non-Rum	Non-ruminant meat production	oapl
ProcDairy	ProcDairy	Processed dairy products	Mil
ProcRum	ProcRum	Processed ruminant meat production	Cmt
ProcNonRum	ProcNonRum	Processed non-ruminant meat production	Omt
Forestry	Forestry	Forestry	Frs
Cveg_Oil	Cveg_Oil	Crude vegetable oil	A portion of vol
	VOBP	Oil meals	A portion of vol
Rveg_Oil	Rveg_Oil	Refined vegetable oil	A portion of vol
Proc_Rice	Proc_Rice	Processed rice	Pcr
Bev_Sug	Bev_Sug	Beverages, tobacco, and sugar	b_t, sgr
Proc_Food	Proc_Food	Processed food products	A portion of ofd
Proc_Feed	Proc_Feed	Processed animal feed products	A portion of ofd
OthPrimSect	OthPrimSect	Other Primary products	fsh, omn
Coal	Coal	Coal	Coa
Oil	Oil	Crude Oil	Oil
Gas	Gas	Natural gas	gas, gdt
Oil_Pcts	Oil_Pcts	Petroleum and coal products	p-c
Electricity	Electricity	Electricity	Ely
En_Int_Ind	En_Int_Ind	Energy intensive Industries	crpn, i_s, nfm, fmp
Oth_Ind_Se	Oth_Ind_Se	Other industry and services	atp, cmn, cns, ele, isr, lea, lum, mvh, nmm, obs, ofi, ome, omf, otn, otp, ppp, ros, tex, trd, wap, wtp
NTrdServices	BTrdServices	Services generating Non-C02 Emissions	wtr, osg, dwe
EthanolC	Ethanol1	Ethanol produced from grains	
	DDGS	Dried Distillers Grains with Solubles	
Ethanol2	Ethanol2	Ethanol produced from sugarcane	
Biodiesel	Biodiesel	Biodiesel produced from vegetable oil	

Table B 2. Regions and their members

Region	Description	Corresponding Countries in GTAP
USA	United States	Usa
EU27	European Union 27	aut, bel, bgr, cyp, cze, deu, dnk, esp, est, fin, fra, gbr, grc, hun, irl, ita, ltu, lux, lva, mlt, nld, pol, prt, rom, svk, svn, swe
BRAZIL	Brazil	Bra
CAN	Canada	Can
JAPAN	Japan	Jpn
CHIHKG	China and Hong Kong	chn, hkg
INDIA	India	Ind
C_C_Amer	Central and Caribbean Americas	mex, xna, xca, xfa, xcb
S_o_Amer	South and Other Americas	col, per, ven, xap, arg, chl, ury, xsm
E_Asia	East Asia	kor, twn, xea
Mala_Indo	Malaysia and Indonesia	ind, mys
R_SE_Asia	Rest of South East Asia	phl, sgp, tha, vnm, xse
R_S_Asia	Rest of South Asia	bgd, lka, xsa
Russia	Russia	Rus
Oth_CEE_CIS	Other East Europe and Rest of Former Soviet Union	xer, alb, hrv, xsu, tur
R_Europe	Rest of European Countries	che, xef
MEAS_NAfr	Middle Eastern and North Africa	xme,mar, tun, xnf
S_S_AFR	Sub Saharan Africa	Bwa, zaf, xsc, mwi, moz, tza, zmb, zwe, xsd, mdg, uga, xss
Oceania	Oceania countries	aus, nzl, xoc

Appendix C
Land Use Changes Due to Ethanol Production

Table C1. Global land use changes due to US ethanol production: Off of 2001 database (1000 hectares)

Region	2001-2006			2006-2007			2007-2009			2009-2011			2011-2013			2013-2015		
	F	C	P	F	C	P	F	C	P	F	C	P	F	C	P	F	C	P
USA	-111	228	-117	-79	163	-84	-74	153	-79	-74	154	-80	-75	155	-80	-75	155	-80
EU27	-33	52	-19	-28	43	-15	-28	43	-15	-30	45	-15	-31	47	-16	-33	49	-17
BRAZIL	-24	35	-11	-20	28	-9	-19	28	-8	-20	29	-9	-21	30	-9	-21	31	-10
CAN	-38	64	-26	-28	47	-19	-27	46	-19	-28	48	-20	-30	51	-21	-31	53	-22
JAPAN	-1	1	0	-1	1	0	-1	1	0	-1	1	0	-1	1	0	-1	1	0
CHIHKG	11	7	-18	9	5	-14	9	5	-14	10	5	-15	10	6	-16	11	6	-17
INDIA	-4	9	-5	-4	8	-4	-4	8	-5	-4	9	-5	-4	10	-5	-5	10	-6
C_C_Amer	-4	12	-8	-3	10	-7	-2	10	-7	-2	10	-8	-2	11	-9	-2	12	-9
S_o_Amer	18	21	-39	13	16	-29	12	16	-28	12	17	-29	13	17	-30	13	18	-31
E_Asia	2	0	-2	1	0	-2	1	0	-1	1	0	-2	1	0	-2	2	0	-2
Mala_Indo	2	-1	-1	1	0	-1	1	0	-1	1	0	-1	1	0	-1	1	0	-1
R_SE_Asia	1	0	-1	1	0	-1	1	0	-1	1	0	-1	1	0	-1	1	0	-1
R_S_Asia	-1	4	-3	-1	4	-3	-1	4	-3	-1	4	-3	-1	4	-3	-1	4	-3
Russia	51	-3	-49	35	-2	-34	33	-1	-32	34	-1	-33	35	-1	-33	35	-1	-34
Oth_CEE_CIS	-2	26	-25	-1	20	-19	-1	20	-19	-1	21	-20	-1	21	-20	-1	22	-21
Oth_Europe	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
MEAS_NAfr	0	18	-18	0	15	-15	0	15	-15	0	15	-15	0	16	-16	0	17	-17
S_S_AFR	-11	115	-104	-12	89	-77	-13	88	-75	-14	92	-78	-16	97	-81	-17	101	-84
Oceania	0	19	-18	0	14	-14	0	14	-13	0	14	-14	0	15	-14	0	15	-15
TOTAL	-144	610	-467	-114	460	-346	-112	448	-336	-117	465	-348	-121	480	-360	-124	495	-371

F, C, and P are stand for Forest, Cropland, and Pastureland, respectively

Table C2. Global land use changes due to US ethanol production: Off of 2006 updated database (1000 hectares)

Region	2001-2006			2006-2007			2007-2009			2009-2011			2011-2013			2013-2015		
	F	C	P	F	C	P	F	C	P	F	C	P	F	C	P	F	C	P
USA	-71	119	-48	-39	76	-37	-35	71	-36	-35	72	-37	-35	73	-38	-35	73	-39
EU27	-13	21	-7	-16	20	-3	-16	20	-4	-18	22	-4	-18	22	-4	-19	23	-4
BRAZIL	-33	23	10	-20	14	6	-17	13	4	-17	14	3	-17	14	3	-17	14	2
CAN	-11	20	-9	-9	11	-2	-8	10	-2	-8	11	-3	-8	11	-3	-8	11	-4
JAPAN	-1	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0
CHIHKG	3	15	-18	-8	16	-8	-6	15	-9	-5	15	-9	-5	15	-10	-5	15	-10
INDIA	-14	29	-15	-8	13	-5	-8	13	-5	-8	14	-5	-8	14	-6	-9	14	-6
C_C_Amer	-6	20	-14	-4	9	-6	-3	9	-6	-3	9	-7	-2	10	-7	-2	10	-7
S_o_Amer	6	23	-29	2	15	-17	2	14	-16	1	15	-16	1	15	-16	1	15	-16
E_Asia	2	2	-4	1	1	-2	1	1	-2	1	1	-2	1	1	-2	1	1	-2
Mala_Indo	-9	10	-1	-7	7	-1	-6	7	-1	-6	7	-1	-6	7	-1	-7	7	-1
R_SE_Asia	-6	6	-1	-5	5	0	-4	4	0	-4	4	0	-4	4	0	-4	4	0
R_S_Asia	-4	18	-14	-2	9	-6	-2	9	-6	-2	9	-7	-2	9	-7	-3	9	-7
Russia	2	21	-23	12	14	-26	11	13	-23	9	13	-23	9	13	-22	8	13	-22
Oth_CEE_CIS	-12	50	-38	-11	24	-12	-10	23	-13	-10	24	-14	-10	24	-14	-10	25	-15
Oth_Europe	-1	1	0	-1	1	0	0	1	0	0	1	0	0	1	0	0	1	0
MEAS_NAfr	0	15	-15	0	7	-8	0	7	-7	0	7	-7	0	7	-7	0	7	-8
S_S_AFR	13	26	-39	8	50	-58	6	49	-54	4	50	-54	3	50	-54	2	51	-53
Oceania	-1	17	-16	-1	10	-9	-1	9	-9	-1	10	-9	-1	10	-9	-1	10	-9
TOTAL	-155	439	-284	-107	302	-194	-98	289	-191	-102	296	-194	-104	301	-197	-106	307	-201

F, C, and P are stand for Forest, Cropland, and Pastureland, respectively

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Table C3. Global land use changes due to US ethanol production: Off of 2006 updated database with yield and population growth after 2006 (1000 hectares)

Region	2001-2006			2006-2007			2007-2009			2009-2011			2011-2013			2013-2015		
	F	C	P	F	C	P	F	C	P	F	C	P	F	C	P	F	C	P
USA	-71	119	-48	-44	59	-15	-54	58	-4	-62	61	1	-67	65	3	-72	70	2
EU27	-13	21	-7	-33	26	7	-39	34	5	-45	44	1	-49	56	-7	-53	68	-15
BRAZIL	-33	23	10	-37	12	25	-38	15	22	-40	19	21	-39	21	18	-37	23	14
CAN	-11	20	-9	-3	10	-7	-5	11	-6	-7	12	-6	-6	13	-7	-4	12	-9
JAPAN	-1	1	0	-1	1	0	-1	1	0	-2	2	0	-2	2	0	-3	3	0
CHIHKG	3	15	-18	-9	-4	13	-17	-9	26	-22	-15	37	-20	-22	42	-12	-28	41
INDIA	-14	29	-15	20	-19	-1	33	-36	3	41	-49	9	42	-55	13	43	-58	15
C_C_Amer	-6	20	-14	-12	13	-1	-20	15	5	-28	19	9	-34	22	12	-40	25	15
S_o_Amer	6	23	-29	1	13	-13	-6	11	-6	-9	10	-1	-11	9	2	-14	8	5
E_Asia	2	2	-4	1	1	-2	1	1	-1	1	0	-1	1	0	-1	1	0	-1
Mala_Indo	-9	10	-1	-1	1	0	1	-1	0	4	-4	0	7	-7	0	9	-9	0
R_SE_Asia	-6	6	-1	-3	2	1	-1	0	1	2	-3	0	5	-5	0	6	-7	0
R_S_Asia	-4	18	-14	-1	2	-2	-1	0	1	-1	-3	4	-1	-5	6	1	-8	8
Russia	2	21	-23	34	6	-41	32	4	-36	36	1	-37	42	-2	-40	50	-6	-43
Oth_CEE_CIS	-12	50	-38	8	41	-49	58	44	-102	93	65	-159	111	98	-210	107	133	-239
Oth_Europe	-1	1	0	-1	1	0	0	1	0	0	1	0	0	1	-1	0	1	-1
MEAS_NAfr	0	15	-15	1	3	-4	1	2	-3	0	1	-1	1	-1	1	1	-4	4
S_S_AFR	13	26	-39	9	36	-45	-8	37	-29	-31	40	-8	-59	45	14	-76	47	30
Oceania	-1	17	-16	-1	6	-4	-2	4	-2	-2	2	0	-1	0	2	-1	-2	3
TOTAL	-155	439	-284	-72	210	-138	-67	192	-125	-70	202	-132	-80	232	-152	-94	266	-172

F, C, and P are stand for Forest, Cropland, and Pastureland, respectively

Appendix D
Experiments Used in Simulations

Introduction

In this appendix first we briefly explain few basic concepts that we use in defining an experiment in GTAP for non professional readers. Then we introduce experiments which we defined for the simulations we introduced in this paper. As we mentioned earlier, GTAP is a computable general equilibrium (CGE) model. This model consists of equations, identities, a database, a set of parameters or elasticities, and several types of variables. Variables in this model are either endogenous (determined within the model) or exogenous (determined outside the model). For example, in GTAP population and tax rates are exogenous variables, but the household demands for goods and services are endogenous variables. The values of the exogenous variables are given to the model but the system determines the values of the endogenous variables using the equations defined in the model.

In GTAP, an experiment consists of a set of commands that guide the system to move the world economy from an existing equilibrium condition to a new equilibrium. The experiment could be simple or complicated. For example, here we introduce two simple experiments.

Suppose that you would like to examine consequences of a 2% increase in the US population for the world economy, assuming no changes in other exogenous variables. For this simple experiment since population is an exogenous variable, we can directly increase (or shock) it by 2% and ask the system to determine consequences of this increase for the world economy. This experiment is simply can be defined by the following command:

Shock pop("US") = 2;

The system starts with the initial equilibrium condition for the world economy (base data), numerically calculates impacts of this shock on the endogenous variables through the equations of the model, and determines a new equilibrium for the world economy.

Now look at another simple experiment. In this experiment we would like to examine impacts of 2% increase in the US demand for meat, while we assume no changes in other exogenous variables. In this case, since the demand for meat is an endogenous variable we cannot directly shock it. Instead, we should shock an exogenous variable which could affect the demand for meat. In this case subsidy is an appropriate exogenous variable. The subsidy on meat consumption could encourage consumers to buy more meat. Now the question is: How much subsidy should be paid to induce the desired increase in the demand for meat? We do not need to answer this question. The system can answer the question through the following swap and shock:

Swap qpd("meat", "US") = tpd("meat", "US");

Shock qpd("meat", "US") = 2;

Here *qpd* and *tpd* represent percentage changes in the demand for meat and its subsidy/tax rate for the US economy. The first command endogenizes the rate of subsidy on meat for the US economy and exogenizes the US demand for this commodity. The second command shocks the US demand for meat, which is now an exogenous variable. The system starts with the initial equilibrium, uses the equations of the system, increases the US subsidy rate on meat to reach 2% increase in the US private demand for meat, and determines a new equilibrium for the world economy through the simulation process. With this introduction we now present the experiments that we used in our simulations. In what follows we present only the main swaps and shocks that derive the results, and we do not present those which we used to fix data problems or avoid minor technical issues.

Experiments of Group 1: Simulations with no economic and yield growth and 2001 base

The experiments used for this group of simulations contain simple shocks and swaps. For the first time period (i.e. 2001-2006) we used the following experiment:

To fix the CRP land of the US

Swap *tf(AEZ_COMM,"Oth_Ind_Se","USA") =*

p_HARVSTAREA_L(AEZ_COMM,"Oth_Ind_Se","USA");

This swap keeps the area of CRP land unchanged. It swaps changes in CRP land with changes in tax rate on land endowment.

To boost ethanol production

Swap *qo("Ethanol1","USA") = tpd("Ethanol1","USA");*

Shock *qo("Ethanol1","USA") = 174.29379;*

Here the swap endogenizes subsidy on ethanol consumption and exogenizes ethanol production and then the shock boosts ethanol production according to its expansion for the time period of 2001-2006 (i.e. 174.3%).

This swap and shock jointly subsidize ethanol production. However, they cause an increase in government subsidies. To offset the impacts of this subsidy we use the following swap to finance the policy through an increase in taxes on biofuel consumption.

To Make the RFS revenue neutral

Swap *del_taxrpcbio("USA") = tpbio("USA");*

Then we repeated the same experiment for other time slices with appropriate percentage changes in ethanol production.

Experiments of Group 2: Simulations with updated baseline for the time period of 2001-2006

For the first time period of this group of simulations we used more complicated shocks and swaps.

To control CRP land of the USA

Swap tf(AEZ_COMM,"Oth_Ind_Se","USA")=qoes(AEZ_COMM,"Oth_Ind_Se","USA");

This swap controls changes in the US CRP land.

To simulate biofuel economy

swap aosec("oil") = pxwcom("oil");

Shock pxwcom("oil") = 136;

Shock afall("ethanol1","Oil_pcts","USA") = -49;

Shock to("Ethanol1","USA") = -10.93;

Shock to("biodiesel","USA") = -7.00;

Shock to("Ethanol1","EU27") = 50.77;

Shock to("biodiesel","EU27") = 81.18;

Swap qo("ethanol1","USA") = tpd("ethanol1","USA");

Swap tms("ethanol2","Brazil","USA") = qxs("ethanol2","Brazil","USA");

Swap qo("biodiesel","USA") = tpd("biodiesel","USA");

Swap qo("ethanol1","EU27") = tpd("ethanol1","EU27");

Swap qo("biodiesel","EU27") = tpd("biodiesel","EU27");

Swap qo("ethanol2","Brazil") = tpd("ethanol2","Brazil");

Shock qo("ethanol1","USA") = 174.29;

Shock qxs("ethanol2","Brazil","USA") = 591.8636;

Shock qo("biodiesel","USA") = 2823.3992;

Shock qo("ethanol1","EU27") = 3444.0395;

Shock qo("biodiesel","EU27") = 409.5644;

Shock qo("ethanol2","Brazil") = 47.39088;

These swaps and shocks jointly introduce changes in the crude oil price and define the US, EU, and Brazil biofuel performances and their supporting policies in this area for the time period of 2001-2006.

To shock population

Shock POP(REG) = file default.prm header "PO16";

This shock reads the regional population growth rates for the time period of 2001-2006 from the parameter file of the system and introduces them to the model.

To shock GDP

Swap afereg(REG) = qgdp(REG);

Shock qgdp(REG) = file default.prm header "IN16";

This shock and swap read percentage changes in the regional GDPs for the time period of 2001-2006 from the parameter file of the system and introduces them to the model.

To shock skilled and unskilled labor

Shock qo("sklab",REG)= file default.prm header "LS16";

Shock qo("Unsklab",REG)=file default.prm header "LU16";

Supplies of skilled and unskilled labor are two important endowments in GTAP. These shocks read percentage changes in labor force for the time period of 2001-2006 from the parameter file

of the system and introduce them to the labor market of each region. The GTAP-BIO does not consider labor movement across regions, meaning that there is no migration.

To shock capital stock

Shock qo("Capital",REG)=file default.prm header "CA16";

Capital stock is a major deriver of economic growth. Unlike the GTAP dynamic, capital stock is an exogenous endowment in the GTAP static model. The above shock introduces changes in the regional capital stocks during the time period of 2001-2006 to the system.

To introduce technological progress

Shock aoall(ALL_INDS,REG) = file default.prm header "PRNE";

Technological progress is another source for economic growth. The above shock introduces technological progress in all industries except for crop industries. Note that the header PRNE contains zero values for crop sectors. The next commands define the technological progress for crop industries. Note that values for technological progress are obtained based on Hertel, Ludena, and Golub (2009) for non-agricultural industries and service.

To shock crop yields

Swap p_YIELD(CROP_INDS,REG) = afall("land",CROP_INDS,REG);

Shock p_YIELD(CROP_INDS,REG) = file default.prm header "YD16";

In GTAP-BIO-ADV crop yields are endogenous variables and they respond to the prices of crops. In this simulation, we use the above swap to make them exogenous. Then we shock them to simulate the historical observation on yield growth for the time period of 2001-2006.

To control forest and pasture land prices

Swap aosec("forestry") = pxwcom("forestry");

Shock pxwcom("forestry") = 21;

Shock aosec("Dairy_Farms")=1;

Shock aosec("Ruminant")=1;

These commands define technological progress for forestry, ruminant, and non ruminant industries according to the observed changes in the world price index of forestry product (21%) during the time period of 2001-2006. It is also necessary to introduce the technology shocks for the dairy and ruminant industries in order to reproduce changes in forest areas.

Finally, for the time slices after 2006 we followed the simple experiments that we introduced for the first group of simulations.

Experiments of Group 3: Simulations with crop yield and population growth for the time period of 2006-20015

The experiment used for the first time slice of this group is similar to the first experiment of the second group of simulations. For the rest of time slices we just shocked population and yield according the assumptions we explained in the text along with shocks for ethanol production.

Appendix E

Woods Hole land use CO_2 emission data set

Definitions:

We used the same Woods Hole emissions data that was used in the Searchinger, et al. paper (2008). The specific source for that data is not given in the paper, but Richard Haughton, one of the authors, is affiliated with Woods Hole.

In this appendix we used the following abbreviations:

FAE_MH: Forest area by ecosystem in million hectares

FAE%: Forest area by ecosystem in percent

CINV_MT/H: Carbon in vegetation in metric ton per hectare

CINS_MT/H: Carbon in soil in metric ton per hectare

DCEFLC_MT/H: Direct carbon emissions from land conversion in metric tons per ha

RGFA_MH: Re-growing forest area in million hectares

GCUBRGF_MMTC/yr: Gross carbon uptake by re-growing forests in million metric tons carbon per year

CUBF_MTC/H/yr: Carbon uptake by forest area in metric ton carbon per hectare per year

FCS30 _MTC/H: Foregone Carbon Sequestration in 30 years in metric ton per hectare

WACE_MT/H: Weighted average carbon emissions in metric ton per hectare

WACO2E_MT/H: Weighted average CO2 emissions in metric ton per hectare

Table C 1. Woods Hole Land use CO_2 emission data-United States

Description	Broad leaf forest	Mixed forest	Wood land	Coniferous / Mountain Forest	Coniferous Pacific Forest	Chaparral	Total Forest	Grassland	Total Grassland
FAE_MH	54.60	88.20	38.50	24.10	29.20	6.20	240.80	0.00	
FAE%	22.67	36.63	15.99	10.01	12.13	2.57	100.00	0.00	0.00
CINV_MT/H	150.00	170.00	90.00	150.00	200.00	40.00		10.00	
CINS_MT/H	150.00	160.00	90.00	100.00	160.00	80.00		80.00	
25% of CINS_MT/H	37.50	40.00	22.50	25.00	40.00	20.00		20.00	
DCEFLC_MTH	150.00	167.50	90.00	137.50	190.00	50.00		30.00	
RGFA_MH	38.00	47.00	47.00	1.00	15.00	0.00		0.00	
GCUBRGF_MMTC/yr	-34.70	-36.40	-2.10	0.00	-23.60	0.00		0.00	
CUBF_MTC/H/yr	-0.64	-0.41	-0.05	0.00	-0.81	0.00			
FCS30 _MTC/H	19.07	12.38	1.64	0.00	24.25	0.00		0.00	
WACE_MT/H	38.33	65.89	14.65	13.76	25.98	1.29	159.90	30.00	30.00
WACO2E_MT/H	140.69	241.80	53.77	50.50	95.35	4.72	586.84	110.10	110.10

Table C 2. Woods Hole Land use CO_2 emission data- North Africa and Middle East

Description	Temperate Evergreen Forest	Tropical Moist Forest	Tropical Woodland	Total Forest	Tropical Grassland	Desert Scrub	Total Grassland
FAE_MH	6.80	2.10	18.50	27.40	44.20	793.10	837.30
FAE%	24.82	7.66	67.52	100.00	5.28	94.72	100.00
CINV_MT/H	160.00	200.00	27.00		18.00	3.00	
CINS_MT/H	134.00	117.00	69.00		42.00	58.00	
25% of CINS_MT/H	33.50	29.25	17.25		10.50	14.50	
DCEFLC_MTH	153.50	179.25	37.50		28.50	17.50	
RGFA_MH	5.00	1.40	0.00		0.00	0.00	
GCUBRGF_MMTC/yr	-14.50	-6.10	0.00		0.00	0.00	
CUBF_MTC/H/yr	-2.13	-2.90	0.00		0.00	0.00	
FCS30 _MTC/H	63.97	87.14	0.00		0.00	0.00	
WACE_MT/H	53.97	20.42	25.32	99.71	1.50	16.58	18.08
WACO2E_MT/H	198.07	74.93	92.92	365.93	5.52	60.83	66.36

Table C 3. Woods Hole Land use CO_2 emission data- Canada

Description	Temperate Evergreen Forest	Temperate Deciduous Forest	Boreal Forest	Total Forest	Temperate Grassland	Tundra	Total Grassland
FAE_MH	37.30	46.10	461.00	544.40	10.90	322.70	333.60
FAE%	6.85	8.47	84.68	100.00	3.27	96.73	100.00
CINV_MT/H	160.00	135.00	90.00		7.00	5.00	0.00
CINS_MT/H	134.00	134.00	206.00		189.00	165.00	0.00
25% of CINS_MT/H	33.50	33.50	51.50		47.25	41.25	0.00
DCEFLC_MTH	153.50	134.75	119.00		54.25	46.25	0.00
RGFA_MH	7.80	1.70	13.00		0.00	0.00	0.00
GCUBRGF_MMTC/yr	-18.50	-3.00	-17.70		0.00	0.00	0.00
CUBF_MTC/H/yr	-0.50	-0.07	-0.04		0.00	0.00	0.00
FCS30 _MTC/H	14.88	1.95	1.15		0.00	0.00	0.00
WACE_MT/H	11.54	11.58	101.75	124.86	1.77	44.74	46.51
WACO2E_MT/H	42.34	42.48	373.40	458.23	6.51	164.19	170.70

Table C 4. Woods Hole Land use CO_2 emission data-Latin America

Description	Tropical Evergreen Forest	Tropical Seasonal Forest	Tropical Open Forest	Temperate Evergreen Forest	Temperate Seasonal Forest	Total Forest	Grassland	Desert	Total Grassland
FAE_MH	296.30	537.30	252.50	53.60	55.40	1195.10	6.90	30.70	
FAE%	24.79	44.96	21.13	4.48	4.64	100.00	18.35	81.65	0.00
CINV_MT/H	200.00	140.00	55.00	168.00	100.00		10.00	6.00	
CINS_MT/H	98.00	98.00	69.00	134.00	134.00		42.00	58.00	
25% of CINS_MT/H	24.50	24.50	17.25	33.50	33.50		10.50	14.50	
DCEFLC_MTH	174.50	129.50	58.50	159.50	108.50		20.50	20.50	
RGFA_MH	0.00	45.60	0.00	14.68	0.00		0.00	0.00	
GCUBRGF_MMTC/yr	0.00	-164.20	0.00	-48.90	0.00		0.00	0.00	
CUBF_MTC/H/yr	0.00	-0.31	0.00	-0.91	0.00		0.00	0.00	
FCS30 _MTC/H	0.00	9.17	0.00	27.37	0.00		0.00	0.00	
WACE_MT/H	43.26	62.34	12.36	8.38	5.03	131.38	3.76	16.74	20.50
WACO2E_MT/H	158.78	228.80	45.36	30.76	18.46	482.15	13.81	61.43	75.24

Table C 5. Woods Hole Land use CO_2 emission data-Pacific Developed

Description	Temperate Evergreen Forest	Temperate Deciduous Forest	Tropical Moist Forest	Tropical Woodland	Total Forest	Tropical Grassland
FAE_MH	14.00	14.00	63.60	106.10	197.70	70.50
FAE%	7.08	7.08	32.17	53.67	100.00	0.00
CINV_MT/H	160.00	135.00	200.00	27.00		18.00
CINS_MT/H	134.00	134.00	117.00	69.00		42.00
25% of CINS_MT/H	33.50	33.50	29.25	17.25		10.50
DCEFLC_MTH	153.50	134.75	179.25	37.50		28.50
RGFA_MH	13.90	13.30	1.90	0.00		0.00
GCUBRGF_MMTC/yr	-33.30	-26.50	-6.00	0.00		0.00
CUBF_MTC/H/yr	-2.38	-1.89	-0.09	0.00		0.00
FCS30 _MTC/H	71.36	56.79	2.83	0.00		0.00
WACE_MT/H	15.92	13.56	58.58	20.13	108.19	28.50
WACO2E_MT/H	58.44	49.78	214.97	73.86	397.05	104.60

Table C 6. Woods Hole Land use CO_2 emission data- South and Southeast Asia

Description	Tropical Moist forest	Tropical Seasonal Forest	Open forest	Total Forest	Temperate Grassland*	Total Grassland
FAE_MH	159.40	137.60	44.90	341.90		
FAE%	46.62	40.25	13.13	100.00		
CINV_MT/H	250.00	150.00	60.00	0.00	7.00	
CINS_MT/H	120.00	80.00	50.00	0.00	189.00	
25% of CINS_MT/H	30.00	20.00	12.50	0.00	47.25	
DCEFLC_MTH	217.50	132.50	57.50	0.00	54.25	
RGFA_MH	70.88	52.39	18.43	0.00		
GCUBRGF_MMTC/yr	-171.10	-108.00	-16.00	0.00		
CUBF_MTC/H/yr	-1.07	-0.78	-0.36	0.00		
FCS30 _MTC/H	32.20	23.55	10.69	0.00		
WACE_MT/H	116.42	62.80	8.96	188.17	54.25	54.25
WACO2E_MT/H	427.25	230.48	32.87	690.59	199.10	199.10

* Figures are belong to China, India, and Pakistan

Table C 7. Woods Hole Land use CO_2 emission data-Africa

Description	Tropical Rain Forest	Tropical Moist Forest	Tropical Dry Forest	Montane Forest	Total Forest	Shrub Land	Total Grassland
FAE_MH	222.00	190.20	200.10	27.70	640.00	47.10	
FAE%	34.69	29.72	31.27	4.33	100.00	100.00	0.00
CINV_MT/H	126.70	60.20	12.60	79.90		4.60	
CINS_MT/H	190.00	115.00	70.00	100.00		30.00	
25% of CINS_MT/H	47.50	28.75	17.50	25.00		7.50	
DCEFLC_MTH	142.53	73.90	26.95	84.93		12.10	
RGFA_MH	21.29	23.73	6.44	0.86		0.67	
GCUBRGF_MMTC/yr	-20.20	-19.90	0.00	0.00		0.00	
CUBF_MTC/H/yr	-0.09	-0.10	0.00	0.00		0.00	
FCS30 _MTC/H	2.73	3.14	0.00	0.00		0.00	
WACE_MT/H	50.39	22.89	8.43	3.68	85.38	12.10	12.10
WACO2E_MT/H	184.91	84.02	30.92	13.49	313.35	44.41	44.41

Table C 8. Woods Hole Land use CO_2 emission data-Europe

Description	Temperate Evergreen Forest	Temperate Deciduous Forest	Boreal Forest	Temperate Woodland	Total Forest	Temperate Grassland	Total Grassland
FAE_MH	71.90	55.50	27.50	45.00	199.90	26.70	
FAE%	35.97	27.76	13.76	22.51	100.00	100.00	0.00
CINV_MT/H	160.00	120.00	90.00	27.00		7.00	
CINS_MT/H	134.00	134.00	206.00	69.00		189.00	
25% of CINS_MT/H	33.50	33.50	51.50	17.25		47.25	
DCEFLC_MTH	153.50	123.50	119.00	37.50		54.25	
RGFA_MH	66.00	43.20	27.20	0.00		0.00	
GCUBRGF_MMTC/yr	-137.50	-80.00	-33.10	0.00		0.00	
CUBF_MTC/H/yr	-1.91	-1.44	-1.20	0.00		0.00	
FCS30 _MTC/H	57.37	43.24	36.11	0.00		0.00	
WACE_MT/H	75.85	46.29	21.34	8.44	151.92	54.25	54.25
WACO2E_MT/H	278.36	169.90	78.31	30.98	557.55	199.10	199.10

Table C 9. Woods Hole Land use CO_2 emission data- Former Soviet Union

Description	Temperate Evergreen Forest	Temperate Deciduous Forest	Boreal Forest	Temperate Woodland	Total Forest	Temperate Grassland	Total Grassland
FAE_MH	88.30	53.60	612.90	186.00	940.80	31.20	
FAE%	9.39	5.70	65.15	19.77	100.00	100.00	0.00
CINV_MT/H	160.00	135.00	90.00	27.00		10.00	
CINS_MT/H	134.00	134.00	206.00	69.00		189.00	
25% of CINS_MT/H	33.50	33.50	51.50	17.25		47.25	
DCEFLC_MTH	153.50	134.75	119.00	37.50		57.25	
RGFA_MH	0.00	0.00	0.00	0.00		0.00	
GCUBRGF_MMTC/yr	-137.50	-80.00	-33.10	0.00		0.00	
CUBF_MTC/H/yr	-1.56	-1.49	-0.05	0.00		0.00	
FCS30 _MTC/H	46.72	44.78	1.62	0.00		0.00	
WACE_MT/H	18.79	10.23	78.58	7.41	115.01	57.25	57.25
WACO2E_MT/H	68.96	37.54	288.39	27.21	422.10	210.11	210.11

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3_B_ADF_GE Responses (Page 25 – 118)

139. Comment: **Exhibit 3**

Agency Response:
This exhibit is a report from Purdue University and is referred to in comment **LCFS B12-6** through **LCFS B12-11**. As such, see the responses to **LCFS B12-6** through **LCFS B12-11** in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **12_B_LCFS_GE**.

Exhibit 4

RFA RENEWABLE FUELS ASSOCIATION

April 28, 2010

Mary D. Nichols, Chairwoman
California Air Resources Board
Headquarters Building
1001 "I" Street
Sacramento, CA 95812

Dear Chairwoman Nichols,

I am writing to inform you and the Board of an important advancement in the science of indirect land use change (ILUC) that has major implications for California's recently adopted Low Carbon Fuels Standard (LCFS). New research conducted and published by Purdue University using the Global Trade Analysis Project model (GTAP) concludes that land use change emissions potentially associated with corn ethanol expansion are likely *less than half* of the level estimated by the California Air Resources Board (ARB) staff for the LCFS. While we continue to have grave concerns about including highly uncertain and prescriptive indirect emissions penalties in the LCFS (for instance, we do not believe ARB has the authority to account for ILUC consistent with the Commerce Clause of the U.S. Constitution), we write to point out the new Purdue findings because we believe ARB has committed itself to consider and respond to critical developments like these. LCFS B12-16

ARB has repeatedly stated that its ILUC analysis for the LCFS was based on the "best available" science and analytical tools, and that the Board is committed to evaluating and adopting advances in the science that would improve the accuracy of its analysis. Indeed, ARB states, "...the GTAP is the best available tool for estimating the global land use change impacts associated with expanded biofuel production. *When and if the Board is made aware of a better estimation tool, it can direct staff to utilize that tool* (emphasis added)."[1] To be sure, Purdue's recent enhancement of the GTAP model and its new ILUC results represent a "better estimation tool" than was used by ARB for the LCFS. Accordingly, we believe that the Board, given its commitments, must direct the staff to adopt the new Purdue results and use the new, improved GTAP model from this point forward until such time that even better tools are available. Because regulated parties under the LCFS will imminently be making decisions about 2011 fuel purchases and related logistics, the Purdue ILUC value should be adopted in the LCFS look-up table *immediately* so that regulated parties have the certainty they need to make purchasing and logistical decisions for the upcoming 2011 LCFS compliance cycle. LCFS B12-17

The new Purdue University research, which was funded in part by the U.S. Department of Energy (DOE), clearly shows that ARB significantly overestimated corn ethanol indirect land use change emissions under the LCFS. In simulations where the most recent available global economic database (2006) was employed and future crop yield increases and population growth were considered, Purdue economists estimated average corn ethanol land use emissions at 13.9 grams LCFS B12-18

[1] Calif. Air Resources Board, California's Low Carbon Fuels Standard: Final Statement of Reasons (December 2009), 633.

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CO2-equivalent per mega joule (g/MJ). These results are less than half of the ILUC value of 30 g/MJ adopted by ARB for the LCFS. Presumably to test the sensitivity of ARB's results to model enhancements excluding the use of the 2006 database, the Purdue researchers also examined a case that mirrored exactly the approach taken by ARB for the LCFS analysis (i.e., the old 2001 GTAP database was used, and crop yield growth and population growth was ignored). Even in this case, Purdue found average corn ethanol land use change emissions to be 20.8 g/MJ, or 31% lower than ARB's estimate of 30 g/MJ. Purdue recently finalized and published these results and shared them with stakeholders, including staff at ARB.[2]

LCFS B12-18 cont.

The new results obtained by Purdue can be compared in an apples-to-apples manner to the ARB LCFS results because in both cases: 1.) the exact same economic model (Purdue's GTAP) was used; 2.) the same corn ethanol production scenario (15 billion gallons by 2015) was examined; and 3.) the same department at the same university conducted the simulations and many of the same researchers were involved. To be clear, the differences between the new Purdue results and ARB's LCFS results stem from the many major improvements that Purdue has made to the GTAP model, not from any discrepancies in the analytical objectives or underlying scenarios. Many of these enhancements were made in response to comments and questions submitted to ARB and Purdue in recent years by stakeholders and other users of the GTAP model. The following are among the major improvements that were made to GTAP:

LCFS B12-19

- *The model's global economic database was updated from 2001 to 2006.* ARB's analysis for the LCFS used the old (2001) GTAP database, while the new Purdue research draws from a recently integrated 2006 database. The authors of the new Purdue paper state, "The global economy changed significantly over the 2001-2006 period..." and there were changes to "...important factors which could alter the land use implications of biofuels."

LCFS B12-20

- *Cropland pasture in the U.S. and Brazil and Conservation Reserve Program (CRP) lands have been added to the model.* These important land types were absent from the model when it was used by ARB and its contractors for the LCFS analysis. Excluding these lands from the model, as ARB did, constrains the amounts and types of land that are available for conversion to crops, which ultimately results in artificially inflated ILUC estimates.

LCFS B12-21

- *According to the Purdue authors, the model's treatment of corn ethanol animal feed co-products (called distillers dried grains, or DDG) is "significantly improved" over the version of model used by ARB for the LCFS.* Despite real world data and information to the contrary, ARB simply assumed for the LCFS analysis that DDG replaces only corn in animal feed rations and only on a pound-for-pound basis.

LCFS B12-22

[2] Purdue economists presented their results at an April 23, 2010, workshop at the University of Chicago. The April 2010 final report was distributed electronically to stakeholders, including ARB staffer John Courtis, on April 15, 2010. The report is available online at http://www.transportation.anl.gov/pdfs/MC/625.PDF.

- *The model's method for estimating crop yields on newly converted(i.e., marginal) lands is much more sophisticated and detailed than previous versions of the model, including the version used by ARB for the LCFS.* The model now estimates crop yields on newly converted lands with regional specificity, rather than applying one generic estimate to all marginal croplands around the world, as ARB did for the LCFS. LCFS B12-23

- *For the new analysis, Purdue took into account crop yield growth and population growth over the period of the simulation.* The new model conservatively assumed growth in crop yields of 1% annually from 2006 to 2015. To account for increased food demand, the Purdue authors also assumed global population will grow at a rate consistent with recent trends. In contrast, ARB ignored both effects for the LCFS analysis and did not assume crop yields would grow at all beyond the period of 2006-2008. LCFS B12-24

- *The new Purdue analysis also assumes that some portion of the carbon stored in trees is not immediately released into the atmosphere when the forest is converted to cropland.* Rather, it is assumed in the new version of the model that a fraction of the carbon in harvested trees will be stored long term in furniture, buildings and other wood products. For the LCFS analysis, ARB assumed 100% of the carbon in trees is immediately released into the atmosphere when the forest is converted (despite the agency's clear statement in the ISOR that it meant to assume that 10% of the carbon would be stored in wood products).[3] LCFS B12-25

In many instances in the LCFS public record, ARB acknowledged that these improvements to the model were necessary. As one example, in regard to the exclusion of cropland pasture and CRP lands, ARB stated that the precision of the GTAP model could be increased by "...expand[ing] the types of land areas available for conversion to agricultural uses. Former Conservation Reserve Program lands could be added in the U.S. Idle croplands that are not currently available could be added worldwide."[4] In regard to this issue, ARB further stated, "There are efforts currently by many institutions and GTAP researchers to include these types of lands in the GTAP database. *Once such a database becomes available, we will evaluate it for possible adoption* (emphasis added)."[5] As another example, ARB also recognized that using the old GTAP database (2001) was a weakness of the analysis. According to ARB, "Staff was aware at the outset of the modeling effort that using 2001 as the baseline year was a limitation. The reason that GTAP employed the 2001 world economic database as the analytical baseline is that this was the most recent year for which a complete global land use database existed as of the time of analysis."[6] Fortunately, a more current world economic database (2006) now exists within GTAP. LCFS B12-26

[3] In its Initial Statement of Reasons, ARB stated that it "...assumed that 90 percent of the above-ground...carbon is emitted over the fuel production period," meaning 10 percent is sequestered in building products. However, this assumption was not reflected in ARB's final ILUC results. When ARB was questioned about why this assumption was not reflected in final calculations, it responded in the FSOR that, "A miscommunication between ARB, UC Berkeley, and Purdue resulted in a discrepancy between the emission factors discussed in the Staff Report (and presented on the ARB website) and the emission factors actually used in the land use change modeling for the regulation." ARB suggested that, "Instead of '90 percent,' the actual assumption was '100 percent.'" A correction was made in errata to fix the "mistake." (FSOR, 651-653)
[4] Calif. Air Resources Board, California's Low Carbon Fuels Standard: Final Statement of Reasons (December 2009), 635.
[5] Ibid., 659
[6] Ibid., 693.

Even after these enhancements were made to GTAP, many uncertainties remain. Still, the new Purdue results are being received by the scientific community as the state-of-the-art in terms of land use change modeling. While the Purdue authors acknowledge that "...modeling land use change is quite uncertain..." and that their analysis is "...limited by data availability, validity of parameters, and other modeling constraints...", the new Purdue study undoubtedly represents the cutting edge and best available science on the issue of land use change and biofuels. Without question, the new Purdue results are superior to the results obtained by ARB in terms of robustness, data currency, and detail. Throughout the LCFS process, ARB has repeatedly stated its intent to integrate modeling improvements and new data as they become available. Indeed, in the LCFS Initial Statement of Reasons, the agency writes, "...ARB has committed to determining the total direct and indirect emissions associated with production, distribution, and use of all fuels through conducting complete lifecycle analyses *based on the best available science* (emphasis added)."[7] Further, ARB suggests, "The Board agrees that the issue of land use change impact estimation must be subject to ongoing evaluation and analysis..."[8] and, "The Board has also committed to an ongoing inquiry into the best indirect land use change estimation methodologies."[9]

LCFS B12-26 cont.

In keeping with ARB's stated commitment to using the best available science and data, the Board should move *immediately* to adopt the value of 13.9 g/MJ for the corn ethanol ILUC penalty in lieu of the current 30 g/MJ estimate. ARB has vociferously committed to adopting advancements in the science of the indirect effects as it becomes available. Integrating the new Purdue value would represent a directional shift in the fuels that would be viewed as viable compliance options, i.e. the current carbon intensity scores prevent most corn ethanol from being used beyond 2011, while adjusting the carbon intensity scores to reflect the new Purdue ILUC value would allow many corn ethanol pathways to serve as viable compliance options for several years under the LCFS. As noted above, any delay in considering and adopting the new Purdue results will seriously hamper the ability of regulated parties to comply with 2011 LCFS obligations. Time is of the essence. The California fuels market simply can't afford to wait for possible modifications to the regulation that may result from the expert work group recommendations (which aren't expected until December 2010). Adopting the Purdue ILUC value immediately would greatly enhance the ability of regulated parties to meet their greenhouse gas reduction obligations in the early years of the LCFS, ultimately minimizing fuel cost impacts to the state's consumers.

LCFS B12-27

Further, there is very recent precedent for ARB making material changes to adopted regulations and adjusting implementation deadlines when new information and better data are presented. Just last week at its April Board meeting, ARB staff acknowledged that its previous estimates of off-road diesel emissions related to the off-highway diesel rule were "too high."[10] New analyses from third parties and ARB itself showed the original off-road emissions inventory may have been overestimated by ARB by 140-400%. At last week's meeting, ARB members stated that

LCFS B12-28

[7] California Air Resources Board, Staff Report: Initial Statement of Reasons, Proposed Regulation to Implement the Low Carbon Fuels Standard: Vol. I (March 5, 2009), Page IV-48
[8] Calif. Air Resources Board, California's Low Carbon Fuels Standard: Final Statement of Reasons (December 2009), 638.
[9] Ibid., 642
[10] Calif. Air Resources Board, Staff Presentation at April 2010 Board meeting (April 22, 2010), slide 10.

additional analysis needs to be conducted and affected parties must be given more time to comply with the rules. Similarly, new analyses presented to ARB in December 2009 led the Board to direct staff to re-evaluate the science behind the pending on-road diesel rules for trucks and buses. One Board member stated the staff report upon which the rule is based is "not acceptable" and proposed that ARB "...set aside the rule until this report be redone."[11] In a similar way, we are urging the Board to re-evaluate the science behind ILUC and consider the new evidence presented in the Purdue paper.

LCFS B12-28 cont.

We appreciate your consideration of this new information and your commitment to ensuring the best available science is appropriately integrated into the LCFS regulation. While we view the new Purdue analysis as being the best available to date, we believe much more research and analysis is needed on the issue of land use change. There is still much room for improvement in the GTAP model and the scientific community still has a great deal to learn, in general, on the topic of biofuels and land use change. We would greatly appreciate the opportunity to meet with you and your staff to discuss the new Purdue results in more detail.

Sincerely,



Bob Dinneen
President & CEO

Cc:

Monica Vehar, Clerk of the Board
John R. Balmes, M.D., Board member
Sandra Berg, Board member
Dorene D'Adamo, Board member
Lydia H. Kennard, Board member
Ronald O. Loveridge, Board member
Barbara Riordan, Board member
Ron Roberts, Board member
Daniel Sperling, Board member
John G. Telles, Board member
Ken Yeager, Board member

[11] Calif. Air Resources Board, Transcript of December 2009 Board meeting (December 9, 2009), 80.

3_B_ADF_GE Responses (Page 119 – 124)

140. Comment: **LCFS B12-16 through LCFS B12-28**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **12_B_LCFS_GE**.

Linda S. Adams
Secretary for
Environmental Protection

Air Resources Board

Mary D. Nichols, Chairman
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Sacramento, California 95812 • www arb ca.gov

Arnold Schwarzenegger
Governor

June 9, 2010

Mr. David Bearden
General Counsel
Renewable Fuels Association
One Massachusetts Avenue, N.W., Suite 820
Washington, D.C. 20001

Re: Petition for Rulemaking

Dear Mr. Bearden:

Thank you for your letter to Chairman Mary D. Nichols dated May 10, 2010. Chairman Nichols has asked that I respond on her behalf. In your letter, you petitioned, pursuant to Government Code section 11340.6, on behalf of Growth Energy for the Air Resources Board (ARB or Board) to amend the Low Carbon Fuel Standard (LCFS) regulation, codified in title 17, California Code of Regulations (CCR), sections 95480-95490. Specifically, you petitioned for amendments to section 95486.

After careful consideration of the facts associated with your request, pursuant to Government Code section 11340.7(b), I am denying your petition to amend the LCFS regulation at this time. However, pursuant to Board Resolution 09-31,[1] I will consider recommending possible changes to the regulation in the future based upon the work being done in conjunction with the Expert Workgroup we convened to assist the Board in refining and improving the land use and indirect effect analysis of transportation fuels. Below I provide further details on our denial of your petition.

Your requested "amendment 1" would take effect no later than December 31, 2010, and would eliminate the land use change carbon intensity of corn ethanol for two years, 2011 and 2012. With respect to this requested amendment, the Board has previously found that crop-based biofuel production does entail land use change impacts, and that those impacts do result in significant greenhouse gas emissions. See Board Resolution 09-31. In light of those findings, the Board determined that it would be remiss if it did not account for land-use change effects in the carbon intensities of crop-based biofuels. Moreover, in the April 2010 report released by Purdue for Argonne

[1] Resolution 09-31, April 23, 2009. See: http://www.arb.ca.gov/regact/2009/lcfs09/res0931.pdf

National Laboratories that you cited, the authors also conclude that "it is simply not credible to argue that there are no land use change implications of corn ethanol." Your petition does not refute the Board's finding that the land use change impacts result in significant greenhouse gas emissions, nor does it refute the study authors' conclusion noted above. Thus, your petition presents an insufficient basis for eliminating the land-use change carbon intensity value for corn ethanol.

Alternatively, "amendment 2" of your petition would lower the indirect land-use carbon intensity value for corn ethanol to one of two values. This requested change is based on the Purdue study you cited in your petition, which we are currently reviewing. As discussed below, it is premature to make changes to the LCFS regulation based on this study. Our initial observation is that the Purdue model used for this study is not publicly available; as a result, a more detailed evaluation is not currently feasible at this time.

As part of the Purdue study, the authors varied a number of parameters which resulted in a range of land use carbon intensity values that are 1/3 to 1/2 lower than ARB's published average value. However, the values are generally within the range of results that we found in running various sensitivities. ARB believes that this is important work and is being considered by the Expert Workgroup as part of its comprehensive evaluation.

As noted, the Expert Workgroup was established at the direction of the Board in Resolution 09-31 upon the Board's approval of the LCFS regulation. The Expert Workgroup is charged with refining and improving the land use and indirect effect analysis of transportation fuels. The Expert Workgroup includes individuals from diverse stakeholder groups such as government agencies, academic institutes (including Purdue University), national laboratories, the biofuel and oil industries, and environmental groups. The Expert Workgroup has formed eight (and potentially nine) subgroups that are actively evaluating all facets of the modeling, including comparative models. For more information on the Expert Workgroup, see the following link: http://www.arb.ca.gov/fuels/lcfs/workgroups/ewg/expertworkgroup.htm.

At the next Expert Workgroup meeting on June 17, 2010, Purdue University representatives will make a presentation on their work so that the Expert Workgroup members will have an understanding of the study, including the key assumptions. We have asked Purdue and Argonne National Laboratories to make the updated Global Trade Analysis Project version publically available for inspection and evaluation. When it becomes available, it is likely that ARB will use Purdue's new work as one of the two baselines for evaluating the impact of inputs and assumptions. The assessment of the Expert Workgroup will be reflected in a report, including recommendations, that the Board will consider at the end of the year.

Because the Expert Workgroup will be assisting ARB staff in evaluating the Purdue study and that work has not yet commenced, it is premature to adopt Purdue's recent work. And, as indicated, our understanding is that the model and the underlying details

which will need to be considered for a full evaluation are not yet available. However, as mentioned above, we believe that assessing this study is an important part of our effort to evaluate developments regarding the indirect effects issue as directed by the Board.

Finally, you also requested an amendment that would take effect no later than September 30, 2010 and would require the Executive Officer to take final action on a Method 2A or 2B submittal under section 95486 within 90 days of his receipt of a complete submittal pursuant to Method 2A or 2B. In approving the LCFS regulation, the Board considered the need for an expeditious process for reviewing a Method 2A or 2B submittal and weighed that need against the public interest in being able to review the submittal in an open process. While we expect most submittals to be reviewed relatively quickly, in some cases, the complexity of a submittal may warrant a staff review that exceeds 90 days. Therefore, the Board determined that the most appropriate balance of these considerations is reflected in the public review and final action provisions contained in section 95486(f). We believe the existing process in the regulation provides a necessary and appropriate balance between these two considerations and have therefore determined that your requested amendment would be inappropriate.

Based on the reasons discussed above, ARB believes that granting the requested changes specified in your petition would be inappropriate at this time. However, as noted, we are continuing to evaluate the ongoing developments in the field of land use and indirect effect analysis of transportation fuels. ARB will consider revisiting the need for updating the indirect effects carbon intensity value for corn ethanol when the Expert Workgroup completes its analysis.

In accordance with Government Code section 11340.7(d), a copy of this letter is being transmitted to the Office of Administrative Law for publication in the California Regulatory Notice Register. The agency contact person on this matter is Ms. Claudia Nagy, Staff Counsel, Office of Legal Affairs, at (916) 445-5501 or cnagy@arb.ca.gov. Any person who is interested in obtaining a copy of the petition may obtain it from her.

Sincerely,

James N. Goldstene
Executive Officer

cc: Ms. Claudia Nagy
Staff Counsel
Office of Legal Affairs

3_B_ADF_GE Responses (Page 125 – 127)

141. Comment: **ARB Letter**

Agency Response:
This exhibit is a letter from Executive Officer James Goldstene responding to David Beardon's Petition. See responses to **LCFS B12-1** through **LCFS B12-15** in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **12_B_LCFS_GE**.

October 14, 2014

Mr. Richard W. Corey, Ph.D.
Executive Officer
California Air Resources Board
1001 I Street
Sacramento, CA 95814

VIA Electronic and Postal Mail

Dear Dr. Corey:

Thank you for the opportunity to participate in the September 29, 2014 workshop on land use change (LUC) emissions. Thank you also for agreeing to provide the updated GTAP model to aid in our evaluation of your latest work in estimating LUC emissions from various feedstocks, and for agreeing to provide the two WRI reports used to evaluate irrigated versus rain-fed cropland.

While some progress in estimating land use emissions has perhaps been made, we have a number of concerns with ARB's presentation and some of the statements made by Staff at the workshop. We summarize each of these concerns below. This letter does not constitute our full comments on the information presented at the workshop, these comments will be submitted by our organizations on or before the due date. However, we thought it was important to highlight these concerns now.

1. AEZ-EF Model

Little has been done to address comments raised on the March 2014 workshop material with respect to the AEZ-EF model. Staff cited contractual reasons for not making progress in this area. However, this now puts ARB in the position of having very little time to address very significant concerns raised by the industry and others. At the same time, while Staff has not made progress in this area, the Staff presentation at page 7 indicates that "minor changes will be made in October 2014", and that the "impacts on ILUC are expected to be negligible." If Staff has not done this work yet, how does Staff know that the impacts on ILUC are expected to be negligible? The comments that were submitted to the Staff following the March workshop, if implemented properly, would not have negligible effects on the emissions. We are therefore disappointed that (1) Staff had not made any progress in this area since March, (2) Staff feel they must now rush to make progress because of deadlines, and (3) Staff are already discounting any impacts these changes may have. This is not a good approach to improving the science of land use change emissions, as it applies to a newly adopted LCFS.

LCFS B12-29

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Washington, DC 20024

2. Irrigated/Rain-Fed Cropland

Working with Purdue, Staff developed separate rain-fed and irrigated cropland categories in GTAP, so that Staff could evaluate the LUC impact of limiting the growth of irrigated cropland where there appears to be evidence that this growth is limited. Since yields are higher on irrigated farmland, this has the effect of lowering the overall new land converted to crops. Staff indicated that the effect of including these new land categories was "small", however, it appears that this comment was based on what would happen between a scenario where some land has irrigated cropland with limitations to a scenario where all land has irrigated cropland with limitations. This is not the correct comparison. The comparison should have been between some irrigated cropland with limitations and no irrigated cropland with limitations (i.e., the baseline model without this change). Staff indicated this latter effect could be up to 5 g/MJ. Given that the new LUC for corn ethanol is 21.6 g/MJ from ARB's most recent modeling, 5 g/MJ, if it applies to corn ethanol, is hardly "small." We will be evaluating this impact in more detail prior to submitting comments on October 15, including the underlying data and rationale developed by WRI for limiting irrigated land expansion in the various AEZs.

LCFS B12-30

3. Effect of Double-Cropping

Double-cropping is not an uncommon practice in many parts of the world when commodity prices are high. Double-cropping directly reduces the pressure to convert pasture, cropland pasture, and forest to crops. There are numerous examples of this. It has been well known that GTAP does not yet account for double-cropping, and since the LCFS was first adopted, comments have been submitted to ARB that ARB should evaluate the LUC impacts of double-cropping. The Expert Work Group elasticities sub-group suggested that if GTAP cannot be modified to directly address double-cropping, the yield-price elasticity could be used to simulate double-cropping effects. And yet, ARB has done nothing in this area. ARB has not even run "what-if" scenarios to determine what kind of impact double cropping would have on the results in countries like the US and Brazil, especially now ARB has apparently modified the model to allow the use of different yield-price elasticities for different crops in different AEZ regions. ARB's lack of progress in this area is unacceptable in improving LUC estimates.

LCFS B12-31

4. Yield-Price Elasticity

ARB attempted to show 2 charts (pages 27 and 28 of the presentation) to support its claim that it the price-yield elasticity could be zero or very close to zero. The first chart plotted yield vs price for US corn from FAO data from 1990-2013. The chart appeared to show no relationship. However, one would never really use this kind of approach to develop a relationship between yield and price; there are simply too many factors changing from year-to-year to develop such a relationship. The second chart was a trend plot of corn yield and price from 1990-2013 (using the same data as the first chart). Since the second chart was a different way of presenting the same data as in the first chart, the same comment applies: there are too many things changing to develop any relationship of yield versus price in these data. ARB made no attempt to isolate just the impact of price changes on yields. Therefore, these two charts prove nothing. Purdue's estimated price yield value is 0.25. ARB evaluated a range from 0.05 to 0.35 (minus 0.2 from Purdue's estimate, and plus 0.1 from the Purdue default). The average from ARB's range is 0.19, 24 percent lower than the value recommend by Purdue. We support analyzing a range of price-yield elasticities, but this range should be from

LCFS B12-32

0.15 to 0.50 with an average somewhat above 0.25 to simulate some double cropping (as recommended in the RFA comments on the March 11 workshop), not 0.15 to 0.35 (which has an average below the value recommended by Purdue without any double cropping).

LCFS B12-32 cont.

5. Cropland Pasture Elasticity

Staff estimated two cropland/pasture elasticitiy scenarios – 0.4/0.2 for US/Brazil, and 0.2/0.1 for US/Brazil. The 0.4/0.2 is the Purdue-estimated set of inputs. Staff has presented no support for its 0.2/0.1 set of inputs, it is simply less than the Purdue-estimated values. Again, if a range is to be used, unless there is specific evidence otherwise to show that the Purdue-estimated values are too high, then the range should be on either side of the Purdue-estimated inputs.

LCFS B12-33

6. Comparison of GTAP Outputs With World Data

ARB has received comments from stakeholders that it should compare GTAP's land use changes to real data. ARB rejects this type of comparison as "not productive", because GTAP is evaluating a single factor (increase in biofuel demand) while factors affecting land use changes in the real world are multiple. ARB then showed charts that compared world forest changes from 2000-2012 with GTAP-estimated changes for several feedstocks. The forest changes for the biofuels were very small in comparison with total forest changes from 2000-2012.

We find ARB's excuses on making no attempt to calibrate land use changes to real world data troubling. The expansion of corn ethanol in the US is predicted by GTAP to have converted 75,000 ha of forest in the US. GTAP also knows where in the US that forest is getting converted. If 75,000 ha of managed forestland have been converted to crops in the last 10 years due to biofuel expansion, then it should be apparent from satellite or other data. ARB should have attempted to validate forest conversions, at least in the US, if not in other major countries with predicted forest conversion.

We find it troubling that ARB apparently does not believe it is productive to validate model predictions by examining real-world empirical data and trends. The principles of sound, science-based policymaking and regulation dictate that model predictions should be validated when possible. Given that ARB's GTAP shock is meant to simulate impacts from 2001-2015, we now have real-world data for the majority of that period.

LCFS B12-34

7. Effect of Fertilizer, Livestock, and Paddy Rice Emissions

The industry first made comments that ARB should evaluate these 3 effects several years ago. ARB has failed to do anything about these issues. EPA evaluated these in 2010 as a part of the RFS. They had a significant impact on EPA's LUC estimates. ARB cites a concern with double counting emissions between GTAP and GREET. EPA, however, also used GREET for direct emissions, and did not have a concern with double counting. ARB has completely failed to explain why it cannot include factors at this time in this update to LUC emissions that EPA successfully included in its analysis 4 years ago as a part of the RFS.

LCFS B12-35

Summary

ARB has perhaps made some progress in updating LUC emissions as part of the LCFS. However, we have serious concerns with the lack of progress in these other areas. There are far too many items that Staff is pushing off to some future update of LUC emissions.

LCFS B12-36

Respectfully,

Geoff Cooper
Renewable Fuels Association

Chris Bliley
Growth Energy

cc:
Mary D. Nichols, Esquire, Chair, California Air Resources Board
Mr. Michael Waugh, Chief, Transportation Fuels Section
Mr. John Courtis, manager, Alternative Fuels Section
Mr. Anil Prabhu, Ph.D. Alternative Fuels Section

3_B_ADF_GE Responses (Page 128 – 131)

142. Comment: **LCFS B12-29 through LCFS B12-36**

Agency Response:
The responses to these comments are in the Low Carbon Fuel Standard Final Statement of Reasons under Comment Letter **12_B_LCFS_GE**.

12_B_LCFS _GE

3_B_ADF _GE

Comments of Growth Energy on the Air Resources Board Staff Presentations at a Public Consultation Meeting on Regulations for Commercialization of Alternative Diesel Fuels

These comments respond to the CARB staff's request for comments on the staff's presentations at the November 21, 2014 public consultation meeting on the proposed adoption of regulations to govern commercialization of alternative diesel fuels, including as part of compliance strategies for the California Low Carbon Fuel Standard ("LCFS") regulation.

1. Methodology for Assessing Impact of Biodiesel Use on NOx Emissions

As Growth Energy has commented previously, CARB staff's approach to assessing the NOx emission impacts of biodiesel and biodiesel blends in heavy-duty diesel engines is flawed.[1] The staff's approach does not adequately protect the environment, in part because it ignores the fact that the existing emissions test data indicate that there are statistically significant increases in emissions of oxides of nitrogen (NOx) at biodiesel blend levels below B5, the lowest level at which CARB staff has chosen to perform testing. As fully explained in an expert report prepared for Growth Energy by Mr. Robert Crawford of Rincon-Ranch Consulting,[2] any sound statistical analysis of the available data indicates that statistically significant increases in NOx emissions occur at biodiesel blend levels below B5.

ADF B3-1

In light of the recent release of biodiesel emissions data by CARB staff, Mr. Crawford has updated his work to include all of that data. The results of this updated analysis were summarized by Jim Lyons of Sierra Research during a presentation made at the October 20, 2014 ADF workshop, and detailed documentation regarding the updated analysis was provided to CARB staff

ADF B3-2

[1] See Attachments A – D.

[2] See Crawford, R., "NOx Emission Impact of Soy- and Animal-based Biodiesel Fuels: A Re-Analysis," December 10, 2013.

by Mr. Lyons via email on October 24, 2014,[3] along with a request that it be posted on agency's ADF website.

As CARB staff has been advised, inclusion of the newly released biodiesel emission test data does not alter Mr. Crawford's previous findings. Likewise, the CARB staff's decision to characterize biodiesels as "low saturation" or "high saturation," instead of "soy" or "animal" based," does nothing to alter Mr. Crawford's findings or protect against increases in NOx emissions resulting from biodiesel use in California. CARB staff has not posted Mr. Crawford's updated analysis on the agency's ADF webpage; has never discussed or explained why it has not adopted Mr. Crawford's approach; and did not discuss Mr. Crawford's revised analysis in any way during the November 21, 2014 workshop. CARB staff appears determined to avoid full public review of the available data, in violation of its environmental protection regulations and the statutes that apply to this rulemaking, including the California Environmental Quality Act ("CEQA") and the Global Warming Solutions Act of 2006 ("AB 32").

ADF B3-2 cont.

2. Proposed Biodiesel Control Levels

For what it treats as low saturation biodiesel blends, CARB staff is proposing a control level of B5 from April 1 to October 31 of each year and a control level of B10 throughout California during the rest of the year. What this means, based on the proposed regulatory language[4] released by CARB staff, is that during the summer, mitigation of increased NOx emissions is not required until low saturation biodiesel blend levels exceed B5 (e.g., B6)—despite the fact that ***CARB staff acknowledges that statistically significant impacts occur at the B5***

ADF B3-3

[3] Although these were already provided to CARB staff, materials related to Mr. Crawford's most recent analysis are attached to these comments.

[4] Proposed Section 2293.6(a)(2).

level.[5] Given this, there can be no dispute that the staff proposal will result in increases in NOx emissions in California. Such an outcome, however, is not permitted under CEQA and AB 32. ADF B3-3 cont.

During the winter the control level for low saturation biodiesel blends increases from B5 to B10, meaning that NOx mitigation is not required until the biodiesel blend level reaches B11. As a result, CARB staff is allowing unmitigated increases in NOx emissions in California to as much as double during the winter. Further, Growth Energy is not aware of, nor has CARB staff identified, any other NOx control measure affecting stationary, area, or mobile sources that is allowed to be relaxed during the winter months anywhere in California. Such an inconsistency cannot be squared with CARB's CEQA obligations or the requirements of AB 32, which include the avoidance of controls that would have the effect of increasing regulated emissions (such as NOx) or hampering compliance with state and federal ambient air quality regulations. ADF B3-4

For high saturation biodiesel blends, CARB staff is proposing a year-round control level of B10, meaning that NOx mitigation is not required until the B11 level. Again, this is above the B10 level at which even CARB staff has determined that statistically significant increases in NOx emissions will occur; therefore, it will allow unmitigated increases in NOx emissions to occur throughout California.

Growth Energy again urges CARB staff to revise its proposal to ensure that it is protective of California air quality by requiring mitigation of potential NOx emission increases from all levels of biodiesel blends, the need for which is indicated by Mr. Crawford's work. CARB cannot risk increases in NOx emissions by failing to require year-round NOx mitigation for low saturation

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[5] This was acknowledged by CARB staff at the October 20th workshop. See *http://www.arb.ca.gov/fuels/diesel/altdiesel/20141017_ADF_statistical_analysis.pdf* and *http://www.arb.ca.gov/fuels/diesel/altdiesel/20141017_ADF_discussion_paper.pdf*

biodiesel blends beginning at the B5 level, and for high saturation biodiesel blends beginning at the B10 level.

ADF B3-4 cont.

3. New Technology Diesel Engines and the Sunset and Exemption Provisions

CARB staff claims, currently without empirical support or any other explanation, that the use of biodiesel blends in so-called "new technology diesel engines" (NTDEs) will not result in increased NOx emissions regardless of the type of biodiesel used or the blend level up to at least B20. Based on that claim, CARB staff is proposing to eliminate the requirements for mitigation of biodiesel-related NOx emission increases when the population of vehicles equipped with NTDEs in the California truck fleet reaches a certain level and for biodiesel blends used by centrally fueled truck fleets that are composed of at least 90% of vehicles equipped with NTDEs. The available studies in the peer-reviewed literature, which have been previously identified by Growth Energy for CARB staff,[6] contradict the staff's claim. The proposed exemptions for fleets of vehicles comprised mainly of vehicles equipped with NTDEs and the sunset provisions are therefore not permitted under the governing statutes because they would permit an unmitigated risk of increased NOx emissions, and adverse impacts on air quality.

ADF B3-5

4. Definitions of CARB Diesel and Blend Level

At present, CARB staff is proposing to define "CARB diesel" to which biodiesel will be allowed to be blended under the ADF regulation as follows:[7]

> *...a light or middle distillate fuel that may be comingled with up to five (5) volume percent biodiesel and meets the definition and requirements for "diesel fuel" or "California nonvehicular diesel fuel" as specified in 13 CCR 2281, et seq. "CARB diesel" may include: renewable diesel; gas-to-liquid fuels; Fischer-Tropsch diesel; CARB diesel blended with additives specifically formulated to reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel;*

ADF B3-6

[6] See Attachment D

[7] Proposed Section 2293.2(a)(9)

and CARB diesel specifically formulated to reduce emissions of one or more criteria or toxic air contaminants relative to reference CARB diesel.

The "blend level" of a biodiesel blend or blend of another ADF would be defined[8] as follows:

...the ratio of an ADF to the CARB diesel it is blended with, expressed as a percent by volume. The blend level may also be expressed as "AXX," where "A" represents the particular ADF and "XX" represents the percent by volume that ADF is present in the blend with CARB diesel (e.g., a 20 percent by volume biodiesel/CARB diesel blend is denoted as "B20").

Because "CARB diesel" can contain up to 5% biodiesel and the control levels proposed by CARB staff above which NOx mitigation is required are defined in terms of "blend levels," the actual biodiesel content of a biodiesel blend under the staff proposal could be as much as 5% greater than the "blend level" used to determine if NOx mitigation is required. Thus, for example, under the staff proposal NOx mitigation of a summer blend of "low saturation" biodiesel blend would not be required even though it contains 10% biodiesel and the unmitigated NOx emissions would be as much as twice those assumed by CARB staff.

ADF B3-6 cont.

There are at least two ways by which CARB staff could easily address this issue. The first would be to require biodiesel blenders to test the CARB diesel fuels they use in order to determine the biodiesel content and type of biodiesel present in a given CARB diesel before blending occurs. The second would be to require that biodiesel blenders use only CARB diesel fuels that have been certified as containing no biodiesel. In any case, CARB staff must modify its proposal to ensure that the actual biodiesel content of blends is accurately known and that appropriate NOx mitigation requirements are imposed. Failure by CARB staff to require accurate measurement and reporting of the biodiesel content of biodiesel blends will lead to unmitigated increases in NOx emissions

[8] Proposed Section 2293.2(a)(4)

along with other potential issues, including violations of pump labeling and vehicle manufacturer warranty requirements.

ADF B3-6 cont.

5. Phase-In Requirements and Program Review

Under the current staff proposal, although the ADF regulation would become effective on January 1, 2016, ***mitigation of increased NOx emissions from the use of biodiesel blends would not be required until 2018.***[9] In addition, CARB staff is proposing to perform a "review" of efficacy of the NOx mitigation requirements of the biodiesel provisions of the ADF regulation by December 31, 2019. [10] As in other respects, the CARB staff proposal fails to adequately protect against adverse air quality impacts and violates the statutes governing this rulemaking. To comply with CEQA and AB 32, the Board must mandate in the ADF rulemaking that mitigation of NOx increases commences as soon as the amended LCFS regulation becomes effective. CARB staff has not explained and cannot explain why California air quality should be exposed for an additional two years to adverse effects from the impacts of increased NOx emissions owing to biodiesel use (which CARB staff itself has estimated to be currently 1.3 tons per day statewide,[11] even after incorrectly assuming that there is no NOx increase from use of biodiesel in NTDEs).

ADF B3-7

Similarly, with respect to the program review, instead of acting to ensure that there are no adverse air quality impacts associated with biodiesel use by proposing mitigation requirements for all biodiesel blends of B1 and above, CARB staff is proposing to wait three years after the implementation of the ADF regulation before making an effort to "determine the efficacy" of the proposed NOx mitigation provisions. As pointed out numerous times in these and previous

ADF B3-8

[9] Proposed Section 2293.6(a)(1)

[10] Proposed Section 2293.6(a)(6)(A)

[11] See *http://www.arb.ca.gov/fuels/diesel/altdiesel/20141017_ADF_discussion_paper.pdf*

Growth Energy comments on the proposed ADF,[12] the currently proposed NOx mitigation provisions are inadequate and will result in increases in NOx emissions and associated adverse impacts on air quality in California. There is no legal basis for waiting until the end of 2019 for CARB staff to make that determination.

ADF B3-8 cont.

6. Authority Granted to the Executive Officer

Under the staff proposal, the Executive Officer, rather than the Board, would be authorized to make findings regarding the potential adverse environmental impacts of potential alternative diesel fuels other than biodiesel.[13] Under CEQA and the Board's implementing regulations, the duty to consider and assess, and to mitigate, potential adverse environmental impacts lies with the Board, not the Executive Officer. In the current rulemaking regarding biodiesel blends, CARB staff is establishing the precedent for the Board, rather than the Executive Officer, to make decisions regarding adverse environment impacts, and the same process must be followed for any future alternative diesel fuel.

ADF B3-9

7. Unfair Competitive Advantages

At present, producers and blenders of biodiesel used in California are allowed to profit from the sale of that fuel under the Low Carbon Fuel Standard (LCFS) regulation through the generation of LCFS credits, despite the fact that use of that fuel results in unmitigated increases in NOx emissions and adverse air quality impacts. Under the proposed ADF regulation, producers and blenders of other alternative diesel fuels would similarly be allowed to profit via the LCFS regulation during Stages 1, 2, and 3a, despite the fact that their products lead to adverse environmental impacts. Such an approach is unexplained and anticompetitive—CARB staff

ADF B3-10

[12] See Attachments A – D.

[13] See for example, proposed Sections 2293.5(b)(3), 2293.5(b)(6) 2293.5(c) and 2293.5(d).

should ensure that no ADF for which adverse environmental impacts have been established can generate LCFS credits ***before the producers of that ADF are required to mitigate those impacts***. For example, if CARB adopts the staff proposal that mitigation of biodiesel NOx impacts is not required until January 1, 2018, then no biodiesel sold in California before that time should be allowed to generate LCFS credits. If this issue is not addressed by CARB staff, producers and blenders of low carbon intensity fuels, such as ethanol, for which mitigation measures must be implemented will be disadvantaged, and producers and blenders of fuels such as biodiesel that are not required to mitigate adverse environmental impacts will be undeservedly rewarded.

ADF B3-10 cont.

Respectfully submitted,

GROWTH ENERGY

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3_B_ADF_GE Responses (Page 132 – 140)

143. Comment: **ADF B3-1, and ADF B3-3 through ADF B3-10**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

144. Comment: ADF **B3-2**
The comment claims that not all Growth Energy input was posted to the ARB webpage, and that ARB staff did not respond to the analysis point-by-point. The comment also states that ARB did not discuss or explain why it had not adopted Mr. Crawford's approach.

Agency Response:
The November 21, 2014 analysis of Mr. Crawford was posted before the Board Hearing and is available at: http://www.arb.ca.gov/fuels/diesel/altdiesel/meetings/20141205GrowthEnergyinput.pdf.

ARB staff reviewed numerous analyses, including Mr. Crawford's analysis, considering it with all other pre-rulemaking input during the rulemaking activity.

ATTACHMENT A

growth energy™
America's Ethanol Supporters

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PHONE 202.545.4000 FAX 202.545.4001 GrowthEnergy.org

December 12, 2013

By Electronic Mail

Clerk of the Board
California Air Resources Board
1001 I Street, 23rd Floor
Sacramento, California 95812

Re: Proposed Regulation to Govern Commercialization of New Alternative Diesel Fuels (2103 Cal. Reg. Notice Register 1646 (October 25, 2013)

Dear Madam:

Growth Energy, an association of the nation's leading ethanol manufacturers and other companies who serve the nation's need for alternative fuels, is submitting to you the enclosed materials in response to the October 15, 2013, notice of proposed regulatory action to establish rules to govern the commercialization of new alternative diesel fuels.

Growth Energy is a strong supporter of biodiesel fuels, which continue to play an important part in our nation's efforts to achieve energy independence with renewable sources and to address environmental concerns. While we applaud the effort to incentivize greater use of all renewable fuels, including biodiesel, we have several significant concerns about the CARB staff's current regulatory proposal and the regulatory process.

Growth Energy believes that significant but feasible changes must be made to the CARB staff's proposed regulations, because the staff's current proposal does not include all reasonable and feasible methods of mitigating potential increases in emissions of oxides of nitrogen ("NOx"), among other reasons. The required changes to the staff's proposal are explained in the enclosed comment and will facilitate the lawful commercialization and use of biodiesel in California in a manner that fully protects the environment. In addition, the CARB staff has not yet publicly released all the test data and analysis on which it is basing its proposal. The decision to postpone the public hearing until March 2014 affords time for the staff to make full disclosure of all the data and analysis. ADF B3-11

Please contact me or David Bearden, our General Counsel, at 605-965-2375 if you have any questions concerning this submission.

Sincerely,

Tom Buis

Tom Buis
CEO, Growth Energy

STATE OF CALIFORNIA

AIR RESOURCES BOARD

PROPOSED REGULATION TO GOVERN THE COMMERCIALIZATION OF NEW ALTERNATIVE DIESEL FUELS

GROWTH ENERGY'S RESPONSE TO THE NOTICE OF PUBLIC HEARING DATED OCTOBER 15, 2013 2013 CAL. REG. NOTICE REG. 1646 (OCTOBER 25, 2013)

DECEMBER 12, 2013

Executive Summary

These Comments by Growth Energy on the proposed regulation to govern the commercialization of alternative diesel fuels address two main issues: (1) the duty of the Air Resources Board to mitigate potential increases in exhaust emissions of oxides of nitrogen ("NOx") from engines operated on biodiesel fuels, and (2) the analytical and procedural obligations for this rulemaking under the governing statutes.

Growth Energy strongly supports the use of biodiesel to achieve the Nation's environmental and energy independence objectives. As with other elements of California's effort to participate in those national strategies, however, the proposed alternative diesel fuel regulation must avoid having unintended negative environmental consequences, and must be considered carefully and in a manner that permits full and effective public participation. The flaws in the current regulatory proposal for alternative diesel fuels can be readily addressed through feasible mitigation measures, which would put biodiesel in parity with other alternative fuels for which the Board has for many years required risk mitigation through regulation. ADF B3-12

As explained in these Comments, a detailed review of the Air Resources Board staff's analysis of the impacts of biodiesel use on NOx emissions, and a reanalysis of the data used by the staff made available to the public, shows that statistically significant increases in NOx emissions must be expected from the use of biodiesel blends of less than ten percent including blends of five percent and lower amounts of biodiesel. Applying the Board's normal precautionary principles, and consistent with the obligations of the California Environmental Quality Act and the Global Warming Solutions Act, the staff's proposed "Significance Level" of ten percent for biodiesel blends should instead be reduced to zero, because the use of biodiesel at any level can be expected to result in increased NOx emissions if not mitigated using reasonable and feasible measures. ADF B3-13

These Comments also show that the potential increases in NOx emissions caused by biodiesel use under the proposed regulation are far larger than the NOx levels considered significant enough to require costly mitigation or control measures in the State's two "extreme" areas for ozone nonattainment -- the South Coast Air Basin and the San Joaquin Valley Air Pollution Control District. It would counterproductive, and not consistent with the governing statutes, for the Board to commit itself to measures that will result in NOx emissions increases in order to implement the low-carbon fuel standard under the Global Warming Solutions Act, especially when those increases greatly exceed the levels for which the State's air quality districts currently require mitigation or control of those emissions when they come from other sources. ADF B3-14

These Comments also urge the Board to ensure that all comments and data received by the staff in connection with this rulemaking effort, or relied upon in formulating the proposed regulation, be placed in the public rulemaking file, and that sufficient time be allowed to review those materials before the Board considers regulatory action. If the Board directs the staff to address these important issues of public access and transparency -- which are governed by the Administrative Procedure Act -- this regulatory item can be completed in a timely manner. ADF B3-15

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Comments of Growth Energy on the Proposed Regulation To Govern the Commercialization of New Alternative Diesel Fuels

Growth Energy respectfully submits these comments on the California Air Resources Board's proposed regulation to govern the commercialization of new alternative diesel fuels (the "proposed ADF regulation"). As explained below, Growth Energy believes that the Board should direct the staff to make revisions in the proposed ADF regulation and cannot adopt the proposed ADF regulation in its current form. The proposed ADF regulation does not require the use of feasible measures that are necessary to mitigate adequately the potential adverse environmental impacts of increased use of biodiesel blends in California.

ADF B3-16

I. INTRODUCTION AND OVERVIEW

CARB's obligation to examine the impacts of widespread biodiesel usage, and to address potential adverse environmental impacts, have recently been clarified by the California Court of Appeal in *POET LLC, et al. v. California Air Resources Board*, (2013) 218 Cal. App. 4th 681. In that litigation, ARB claimed that it intended to "ensure" that there would be "no" increase in regulated pollutants from Diesel-powered engines in California as a result of the LCFS regulation, and in particular that there would be no increase in exhaust emissions of oxides of nitrogen ("NOx") resulting from the use of biodiesel fuel. 218 Cal. App. 4th at 732.

ADF B3-17

The CARB staff's proposed approach to the task of NOx mitigation in the proposed ADF regulation falls far short of the claimed metric: whatever the benefits of the proposed ADF regulation for other purposes, the staff's approach will not ***ensure*** that the implementation of the LCFS regulation can cause ***no*** increase in NOx emissions. These comments briefly outline, and the accompanying materials fully explain, the unnecessary environmental risks to the State's

efforts to control NOx emissions that the proposed ADF regulation fails to address.[1] Those risks are not based on unqualified speculation, or merely the opinion of Growth Energy; the risks can be demonstrated from the emissions data that the CARB staff has placed in the docket, when those data are evaluated using simple but appropriate statistical tools and methods.[2] Moreover, the increases in NOx emissions, which the CARB staff's data establish, are significant by any contemporary measure: the increases in NOx emissions that the increased use of biodiesel will cause as a result of the LCFS regulation are many times larger than the NOx increases that CARB and regional air quality authorities require to be mitigated. (*See* pp. 18-19 below.)

ADF B3-17 cont.

Addressing the problem of increased NOx emissions is a feasible task, as the Staff Report that accompanies the proposed ADF regulation concedes. Once the risk is established, and the methods of mitigation are determined to be feasible, CARB's task is clear: under the California Environmental Quality Act ("CEQA"), it must require mitigation before it can proceed with regulation.[3]

In this instance, mitigation may impose direct costs on the firms that choose to use biodiesel to comply with the LCFS regulation, and indirect costs on the operators of Diesel engines, but CARB decided nearly five years ago that the benefits of the LCFS regulation overall were worth the costs. In that respect, biodiesel should be treated no differently than the

[1] In addition to the materials cited below in notes 2 and 4, Growth Energy is also attaching to these comments for inclusion in the rulemaking file -- and for analysis and response by the Board -- its earlier comments on the CARB staff's ADF regulatory proposal, submitted on September 16, 2013. Those comments, and likely many other comments from other parties, were not placed in the rulemaking file when CARB issued its 45-day notice. *See* pp. 13-14 below (requirements of the California Administrative Procedure Act).

[2] *See* R. Crawford, "NOx Emissions Impact of Soy- and Animal-Based Biodiesel Fuels: A Re-Analysis" (Dec. 2013) (hereinafter "Crawford Report"), attached to these Comments as Exhibit A.

[3] *See POET*, 218 Cal. App. 4th at 731-742.

alternative fuels that the LCFS regulation requires for gasoline, which are ethanol, natural gas and electricity.

ADF B3-17 cont.

Instead of requiring the Diesel sector to bear its fair share of the costs of the LCFS regulation through proper environmental mitigation, however, the CARB staff's proposed approach deploys what the Staff Report calls an "Effective Blend Level" concept to exempt biodiesel fuel from any meaningful mitigation requirement.[4] Rather than following the precautionary principles that have constantly guided CARB rulemaking -- which in other contexts sometimes have inclined the Board to require extreme regulatory stringency based on scant evidence of actual harm -- in this one instance, the CARB staff appears intent on risking air quality rather than requiring feasible, if costly to some, mitigation measures. The CARB Staff Report suggests in one place that this deviation from the Board's longstanding regulatory strategy may be necessary to protect the growth of the biodiesel "market."[5] But the CARB staff cites no evidence to support its speculation that the biodiesel "market" is at risk, and there is no evidence of such a risk in the public rulemaking file. Even if such a private market risk existed, however, neither the California Global Warming Solutions Act nor the California Government Code allow CARB to consider factors extrinsic to the statutes in meeting the clean-air goals established by law.[6] The California statutes protect California citizens and air quality, not market entrepreneurs and arbitragers. It is not the proper purpose of any California regulation to

ADF B3-18

[4] *See* Declaration of James M. Lyons (hereinafter "Lyons Decl."), attached to these Comments as Exhibit B.

[5] *See* Staff Report at 63 (rejecting "immediate" mitigation because "this option has the potential to disrupt or even collapse the burgeoning ADF market by unnecessarily placing overly restrictive requirements that are not warranted by emissions testing"). Tellingly, that portion of the Staff Report has no citations to support the claim.

[6] In its current proposal, the CARB staff is engrafting onto the Global Warming Solutions Act a provision allowing it to avoid mitigation of environmental harm, in order to encourage particular industries or based on general economic preferences. CARB cannot proceed in that fashion. *Cf. Clean Air Constituency v. CARB*, (1974) 11 Cal.3d 801 (CARB lacks authority to establish criteria to govern its actions that are not found in its enabling statutes).

pick "winners" and "losers:" all fuels, including all alternative fuels, must have their environmental risks properly assessed, and when feasible mitigated in full.

ADF B3-18 cont.

The balance of these Comments is divided into two parts. The first part, in Section II below, summarizes the technical analyses contained in the accompanying report of Robert Crawford, a statistician with expertise in evaluation of emissions data, and in the Declaration of James M. Lyons, an expert in automotive air pollution who evaluates the "Effective Blend Level" concept as a method of addressing the risks of increased NOx emissions. Section II also summarizes the relevant portions of the Staff Report dealing with the available mitigation methods and their feasibility. The second part, in Section III below, explains the Board's legal obligations to mitigate the risks of increased NOx emissions presented by biodiesel fuel usage.

II. ENVIRONMENTAL ASSESSMENT OF THE PROPOSED REGULATION

Were the matter ever in any doubt, the Court of Appeal's *POET* decision, which the California Supreme Court has recently declined to review, makes it clear that the Board must take seriously the issue of NOx emissions increases from the increased use of biodiesel in order to comply with the LCFS regulation. CARB has recognized, first in the LCFS regulatory process and more recently in court, that the LCFS regulation will increase the use of biodiesel. The CARB staff now claims in the current ADF rulemaking, however, that emissions testing proves that the use of biodiesel blends containing less than 10 percent biodiesel will not increase NOx emissions. That claim is demonstrably wrong, as Mr. Crawford establishes in his analysis of the available emissions data. (*See* Exhibit A and Section A below.) Because the data do not support the CARB staff's claims that operation of engines on blends below 10 percent biodiesel will not increase NOx emissions, and in fact show the opposite, CARB has a duty to mitigate. The CARB staff's environmental analysis is also unsound in other respects as well, as demonstrated in Mr. Lyons' Declaration. (*See* Exhibit B and Section B below.)

ADF B3-19

A. Impact of the Proposed Regulation on Exhaust Emissions of Oxides of Nitrogen

Mr. Crawford's report carefully reviews each of the six studies cited in the CARB staff's literature review on biodiesel NOx emissions, as well as CARB's biodiesel characterization study ("Durbin 2011") and the data available from that study. It is important to note at the outset that not all the data from the CARB study has been made available to the public. CARB should publish all of the testing presented in Durbin 2011[7] and any future testing that it sponsors in a complete format that allows for reanalysis, and an opportunity to evaluate those materials prior to the deadline for submission of public comments or CARB's hearing on the approval of the proposed ADF regulation. ADF B3-20

Putting aside the CARB staff's failure to make a complete disclosure of the data reflected in Durbin 2011, it is clear that the data from Durbin and the other six studies do not support the CARB staff's conclusion and, indeed, the data refute the staff's conclusion in some instances. These are the salient points from Mr. Crawford's analysis:

- There is ***no evidence*** supporting the staff conclusion that NOx emissions do not increase until the B10 level is reached. Instead, there is consistent and strong evidence that biodiesel increases NOx emissions in proportion to the biodiesel blending percent. ADF B3-21
- There is ***clear and statistically significant evidence*** that biodiesel increases NOx emissions at the B5 level in at least some engines for both soy- and animal-based biodiesels. ADF B3-22

None of the six studies in the literature measured the NOx emissions impact from biodiesel at blending levels below B10. Only two studies tested a fuel at the B10 level. All

[7] The data should be published in a useable format, and should include (a) the measured emission values for each individual test replication; or (b) averages across all test replications, along with the number of replications and the standard error of the individual tests. The first format (individual test replications) is preferable because that would permit a full examination of the data including effects such as test cell drift over time.

other testing was at the B20 level or higher. Because none tested a B5 (or similar) fuel, the studies do not constitute substantial evidence that NOx emissions are not increased at B5 or other blending levels below B10. Those six studies therefore provide no data or evidence supporting the validity of the staff's claim that biodiesel below B10 does not increase NOx emissions. To the contrary, all of the studies are consistent with the contention that biodiesel increases NOx emissions in proportion to the blending percent. Indeed, two of those six studies present evidence and data that the NOx impact from biodiesel is a continuous effect that is present even at very low blending levels and will increase at higher levels in proportion to the blending percentage.

ADF B3-22 cont.

With regard to the CARB biodiesel characterization report, Mr. Crawford has uncovered the fact that for the three engines for which the CARB staff has published the emission values measured in engine dynamometer testing, all of the data demonstrate that biodiesel fuels significantly increase NOx emissions for both soy- and animal-based fuels by amounts that are proportional to the blending percent. That is true for on-road and off-road engines and for a range of test cycles. When B5 fuels were tested for those engines, NOx emissions were observed to increase. NOx emission increases are smaller at B5 than at higher blending levels and the observed increases for two engines were not statistically significant by themselves based on the pair-wise t-test employed in Durbin 2011. However, the testing for one of the engines (the 2007 MBE4000) showed statistically significant NOx emission increases at the B5 level for both soy- and animal-based blends. The data are sufficient to disprove the staff's contention that biodiesel blends at the B5 level will not increase NOx emissions.

ADF B3-23

In sum, based on examination of all of the studies cited by CARB as the basis for its proposal to exempt biodiesels below B10 from mitigation, it is clear that the available research

ADF B3-24

points to a very substantial risk, if not a certainty, that both soy- and animal-based biodiesel blends will increase NOx emissions in proportion to their biodiesel content, including at the B5 level. Based on data in the CARB Biodiesel Characterization Report, soy-based biodiesels will increase NOx emissions by about 1% at B5 and 2% at B10, while animal-based biodiesels will increase NOx emissions by about one-half as much: 0.45% at B5 and 0.9% at B10. All of the available research shows that the NOx increases are real and implementation of mitigation measures will be required to prevent increases in NOx emissions due to biodiesel use at blending levels below B10. The available research likewise demonstrates that, to the extent CARB is identifying B10 as a "threshold of significance" under CEQA, (1) the utilization of this threshold is unsupported by the evidence in the record. For the same reasons, and for the reasons discussed in Section III.B below, the utilization of B10 as a "threshold" is contrary to the Legislature's mandate that the regulations should "not interfere with … efforts to achieve and maintain federal and state ambient air quality standards." Cal Health & Safety Code § 38562(b)(4).

ADF B3-24 cont.

ADF B3-25

B. The "Effective Blend Level" Concept

Mr. Lyons' Declaration builds on the analysis performed by Mr. Crawford and demonstrates that the CARB staff's "effective blend level" concept will operate to exempt biodiesel from any meaningful mitigation, even if biodiesel is causing real-world increases in NOx exhaust emissions from Diesel engines operated in California. Mr. Lyons demonstrates, in particular, that "despite the forecast nine-fold increase in biodiesel use in California from 50 million to 450 million gallons from 2013 to 2023 … the forecast Effective Blend Level of biodiesel decreases to less than zero over virtually all of the period in question." (Lyons Decl. ¶ 14.)

ADF B3-26

If the fractional coefficients being applied in the "effective blend level" equation (*see* Lyons Decl. ¶¶ 11-12) are incorrect to any significant extent, the environment will not be protected. The CARB staff has apparently selected those coefficients without allowing for the possibility of errors that could understate NOx impacts -- a clear violation of CARB's precautionary norms. The adverse effects will be severe if there is error in the coefficients, because the CARB staff itself recites evidence that the biodiesel market will be concentrated in low-blend biodiesel. (*See* Lyons Decl. ¶¶ 15, 17.) Growth Energy is aware of no other regulatory concept in any CARB program in which mitigation measures required by CEQA depend on a formula that could err as easily as the "effective blend level" equation could.

ADF B3-27

The mischief in the "effective blend level" coefficients lies in their complexity and the risk of quantitative error. A much simpler but equally fatal analytical flaw, which also violates both sound regulatory policy and the requirements of CEQA, is the failure of the effective blend level calculation to ensure that any NOx increases that require mitigation will be addressed by the use of a mitigation measure in the ***same*** relevant location, and at the ***same*** time, as the NOx increases are occurring. If NOx mitigation does not occur in the same area and at the same time as biodiesel use that increases NOx emissions, the environmental harm presented by those increased NOx emissions will go unmitigated; the adverse impacts of NOx increases are defined by their location, and their severity is greatest at the time when the emissions occur.

ADF B3-28

As Mr. Lyons points out, the "effective blend level" concept does not fully protect, for example, Los Angeles residents, if NOx increases experienced in the summertime in Los Angeles can be offset by the biodiesel "market" in whole or part by practices that mitigate those emissions in a different season and in another place. (*See* Lyons Decl. ¶¶ 19-20.) The regulation, as proposed by the CARB staff, does nothing even to incentivize, much less require,

ADF B3-29

the biodiesel "market" to deliver mitigation at the time and place it is needed. That may be a result of the CARB staff's conclusion that, as they have written the mitigation rule, it is unlikely that mitigation will ever be required; if so, that simply underscores the weakness of the mitigation rule itself (*see*, *e.g.*, Lyons Decl. ¶¶ 8-10, 15-18). CEQA and its implementing guidelines must be read to require mitigation where and when the adverse effect would otherwise occur. By not accounting for that requirement, the "effective blend level" concept violates CEQA.

ADF B3-29 cont.

Mr. Lyons' Declaration identifies other flaws in the staff proposal that must be addressed. As his Declaration establishes, the data on which CARB relies for its assumption that "new-technology" diesel engines will have lower NOx emissions when operated on biodiesel is inadequate to support the weight it is given by the CARB staff (*see* Lyons Decl. ¶¶ 21-23); that data cannot be treated as substantial evidence to support a regulation that posits lower emissions from such engines. Each of the issues raised in Mr. Lyons' Declaration must be addressed by the Board.

ADF B3-30

C. Available Mitigation Measures

Mitigation of the risks of NOx increases from biodiesel usage is entirely feasible. The proposed ADF regulation can easily be modified to ensure that the use of biodiesel will not result in increased NOx emissions by setting the "Significance Level" for biodiesel blends at zero -- which is the level that the available data require -- so that mitigation would occur whenever and wherever it should. In addition, CARB must eliminate the use of annual statewide averages for determining the "effective blend levels" and instead use actual blend levels at the batch level. These two changes would require that mitigation be applied to all biodiesel blends in light of the actual amount of biodiesel present in each specific blend.

ADF B3-31

Appendix 1 to proposed Section 2293.5(c) specifies the three mitigation measures that CARB staff has identified for mitigation of increases in NOx emissions due to biodiesel use. They include (i) addition of di-tert-butyl peroxide to biodiesel blends at a level that varies with the amount of biodiesel in the blend and (ii) blending of low-NOx diesel fuel along with biodiesel into biodiesel blends. Under the staff's proposal, parties responsible for mitigation of increased NOx emissions from biodiesel can choose either of those approaches. They all could be easily applied to any blend containing ten percent or less biodiesel, as well as blends of more than ten percent, if appropriately modified to ensure that there would be no increase in NOx emissions associated with the use of biodiesel. The Staff Report and the rulemaking file contain no significant evidence that such approaches could not be applied at the batch level.

ADF B3-32

In addition to conceding the feasibility of the three identified mitigation measures by including them in the proposed ADF regulation, the Staff Report also provides cost estimates for the application of each measure.[8] Absorption of those estimated costs by entities or individuals choosing to use biodiesel is in no way inconsistent with the types of costs that have been imposed by CARB on other California businesses and residents in other regulatory programs. Indeed, the Global Warming Solutions Act gives CARB no choice but to require the regulated parties and their downstream customers to absorb those costs: the Legislature has specifically directed that CARB is to "ensure" that "activities undertaken pursuant to the regulations" adopted to implement the Act -- including the use of biodiesel to comply with the LCFS regulation -- "do not interfere with ... efforts to achieve and maintain federal and state ambient air quality standards." Cal. Health & Safety Code § 38562(b)(4).

ADF B3-33

[8] Those costs are $0.25 per gallon of biodiesel blended for di-tert-butyl peroxide, $1.20 per gallon of biodiesel blended for low-NOx diesel and a one-time expense of between $100,000 and $200,000 for the certification of a biodiesel blend that could then be sold in California in any volume. *See* Staff Report at 59 and *id.* App. C.

In addition to being technically feasible, consistent with costs required by other CARB regulations, the mitigation measures outlined in the Staff Report can be implemented. In some instances, regulated parties would simply have to ensure that steps have been taken to ensure their final blends meet the fuel property specifications associated with the certified blend. Mitigation using di-tert-butyl peroxide or low NOx diesel requires only knowing the amount of biodiesel in the blend and ensuring that the entity performing the blending also be responsible for adding di-tert-butyl peroxide or low NOx diesel to the blend. ADF B3-34

The Staff Report claims that "[i]t would be impractical to determine the individual blend level for each gallon of biodiesel blend being sold across the State." The Staff Report continues: "To do so would require the retailers and marketers of biodiesel blends (i.e., the diesel dispensing facilities) to continuously test and determine the biodiesel blend level for each of the approximately 3 billion gallons of on-road diesel fuel sold in California each year."[9] The Staff Report offers no support for that claim, however, and it is contradicted by the overall regulatory experience under the LCFS regulation as well as the data necessary to actually to employ the Effective Blend concept. The LCFS regulation already requires producers of biodiesel sold in California or other entities to which the fuel is transferred to report the volumes of biodiesel to CARB via the Low Carbon Fuel Standard Reporting Tool ("LRT") in order to receive greenhouse gas emission reduction credits. (*See* 17 C.C.R. § 95484(b)(B)(2).) Moreover, in order to employ the Effective Blend concept, data regarding the amount of biodiesel used in blends of five percent or less, as well as the type and volumes of biodiesel used in blends of more than five percent, would be required. Presumably, this data will also be derived from the LRT. The LRT is currently treated by CARB as an accurate source of data regarding biodiesel use in ADF B3-35

[9] Staff Report at 23.

California.[10] The CARB staff regularly publishes quarterly summaries of greenhouse gas credits generated from biodiesel and other fuels under the LCFS.[11]

ADF B3-35 cont.

Given that biodiesel producers must report both their production volumes and production pathways (*e.g.*, soy-based, animal-based, or other) to CARB via the LRT in order to generate greenhouse gas credits under the LCFS regulation, the implementation of NOx mitigation measures involving use of di-tert-butyl peroxide or low NOx diesel under the ADF regulation would be simple and straightforward. All that CARB would have to do is to require entities earning greenhouse gas credits under the LCFS for non-certified biodiesel blends to also report to CARB via the LRT how, when, and where mitigation of the NOx emissions associated with the use of that biodiesel via di-tert-butyl peroxide or low NOx diesel was achieved. Recordkeeping requirements analogous to those that already apply to data reported via the LRT would also apply to mitigation of biodiesel NOx impacts.

ADF B3-36

By following that approach, CARB staff can both ensure that there are no NOx increases associated with the use of biodiesel in California while simultaneously avoiding any need to involve retailers and marketers of biodiesel in the "impractical" activity described in the Staff Report unless those same retailers and marketers of biodiesel were earning greenhouse gas reduction credits from biodiesel under the LCFS. If the CARB Executive Officer or the staff disagrees with Growth Energy on this point, it is incumbent upon them to explain why and for the Board to give the public an opportunity to respond before CARB weighs the evidence and arguments, because this is an issue involving available and practical mitigation measures under CEQA.

ADF B3-37

[10] *See, e.g.*, Staff Report at 30.

[11] The most recent summary for the second quarter of 2013 is available at http://www.arb.ca.gov/fuels/lcfs/20130930_q2datasummary.pdf.

III. THE BOARD'S LEGAL OBLIGATIONS

The Court of Appeal clarified in *POET* that CARB is subject, among other provisions, to sections 15004 and 15352 of the CEQA Guidelines. The Court of Appeal also gave clear instructions about the need to comply with the rulemaking-file requirements of the Administrative Procedure Act. Perhaps most importantly, the Court of Appeal made plain the Board's duty to mitigate, in particular with respect to the subject of NOx exhaust emissions from engines operated on biodiesel. This final section of Growth Energy's comments summarizes the steps that CARB must take to meet its obligations under the governing statutes as clarified by the Court in *POET*, with primary emphasis on the duty to mitigate under CEQA.

A. Procedural and Structural Rulemaking Requirements

CARB must recognize that *any* communications it has received of a factual nature, or data that it has acquired in connection with regulatory action, are not exempt from the requirement to disclose those communications in the public rulemaking file under Gov't Code § 11347.3 (absent a valid and complete demonstration of privilege). *See POET*, 218 Cal. App. 4th at 741-754. At present, the rulemaking file for the ADF proposal cannot possibly be claimed to include all material required for the rulemaking file: Growth Energy knows this, because its own comments of September 16, 2013 (*see* Exhibit C) have not been placed in that file. As noted above, CARB has apparently not made full disclosure of all data relevant to the Durbin emissions study. (*See* p. 5 above.) Likewise, the Staff Report claims that the proposed ADF regulation "is based upon feedback from nearly every corner of the regulated industry as well as other impacted organizations and individuals that are impacted by actions concerning or that regulate the fuels industry."[12] The rulemaking file, when last checked in the week of

ADF B3-38

ADF B3-39

[12] Staff Report at 3-4.

December 2, 2013, did not contain any written comments reflecting that "feedback;" those materials should have been in the rulemaking file no later than October 15, 2013, when the public hearing on the proposed ADF regulation was announced. *See* Cal. Gov't Code § 11347.3(a), (b)(6), (7).

ADF B3-39 cont.

Accordingly, one of the first steps that CARB must take in the current proceeding is to ensure compliance with section 11347.3 of the Government Code, and re-issue a notice of proposed rulemaking to allow 45 days of comment prior to a public hearing at which it would take action on a proposed ADF regulation. If CARB takes this action quickly, there will be no delay in program objections, including reconsideration of the LCFS standards during 2014.

ADF B3-40

It is also clear from *POET* that, as CEQA and the guidelines direct, there are other reasons why CARB cannot take action with respect to the proposed ADF regulation. *See POET*, 218 Cal. App. 4th at 717-731. If CARB is the decision-maker with respect to the proposed ADF regulation, it must evaluate the environmental issues presented by the staff proposal for itself, and complete the environmental review process required under CEQA and CARB regulations, *before* the Board commits CARB to the proposed ADF regulation. Likewise, the opportunity to participate in the environmental analysis must be adequate -- which in this instance, it is not, in part because not all the relevant data has been publicly released. A comment deadline scarcely 45 days after the staff analysis has been released, when all relevant data have not been provided, will not permit an adequate environmental assessment.

ADF B3-41

To comply with the procedural requirements of CEQA as confirmed in *POET*, CARB should direct the staff to complete the environmental review process (including full disclosure of the basis for its proposal); prepare a complete rulemaking file; respond to public comment; and publish a Final Statement of Reasons, before considering the proposed ADF regulation on its

ADF B3-42

merits at a subsequent hearing. At that hearing, interested parties should be allowed all the time required to present and to respond to legitimate technical, empirically-based analysis of the environmental issues presented by the proposed ADF regulation. CARB can neither approve the proposed ADF regulation with the record in its current status and at the type of hearing planned for this week, nor defer the environmental assessment to a point after it has committed itself to the proposed regulation, nor delegate any of its CEQA responsibilities identified by the Court of Appeal in *POET*.

ADF B3-42 cont.

B. The Duty to Analyze Potential Impacts and Mitigate Significant Impacts

The importance of NOx emissions control for California air quality is well known and is illustrated, for example, by a June 2012 CARB Report entitled "Vision for Clean Air: A Framework for Air Quality and Climate Planning," prepared in conjunction with the South Coast Air Quality Management District and the San Joaquin Valley Unified Air Pollution Control District.[13] That report addressed potential control strategies that will be required to bring the only two areas of the country designated as being in extreme nonattainment of the National Ambient Air Quality Standard ("NAAQS") for ozone[14] into attainment. In working to identify potential control strategies, these three agencies chose to focus on ways to reduce NOx emissions (and not hydrocarbon emissions) because "NOx is the most critical pollutant for reducing regional ozone and fine particulate matter."[15] The report also identifies diesel-powered heavy-duty vehicles as the largest source of NOx emissions in California, and classifies diesel-powered

ADF B3-43

[13] *See* CARB, Vision for Clean Air: A Framework for Air Quality and Climate Planning (June 27, 2012) (available at http://www.arb.ca.gov/planning/vision/docs/vision_for_clean_air_public_review_draft.pdf).

[14] *See* http://www.epa.gov/airquality/ozonepollution/designations/2008standards/final/region9f.htm.

[15] *See* Vision for Clean Air at 10.

construction, mining and agricultural equipment as other significant sources of NOx emissions in California.

ADF B3-43 cont.

As indicated above, CEQA requires that mitigation measures must be implemented locally and must be contemporaneous with the emissions events of concern; the type of statewide mitigation concept contained in the Staff Report, unbounded to relevant time intervals, does not comply with CEQA. It is therefore relevant to consider, by way of example, the heavy-duty diesel vehicle NOx emissions inventory for the South Coast and San Joaquin Valley areas during calendar years 2015 and 2020. On-road heavy-duty diesel emission estimates were developed using CARB's latest emission factor modeling software EMFAC2011.[16] The model estimates regional emissions, in tons/day, by vehicle class and model year. Emission estimates were computed for both older vehicles as well as vehicles using what CARB would consider to be NTDEs -- which in this case were assumed to be 2010 and later model-year vehicles. Emissions from off-road construction equipment were estimated using CARB's 2011 In-Use Inventory model.[17] Emissions from agricultural equipment were developed using CARB's OFFROAD2007 model because CARB's regulatory in-use inventory model is still under development for this sector.[18] For construction and agricultural equipment, NTDE vehicles were assumed to be those with engines certified to Tier 4 emission standards. It was assumed Tier 4 engines are used in 2013-and-later model year engines rated at or below 50 HP, 2014-and-later model year engines between 51 and 750 HP, and to 2015-and-later model years for engines

ADF B3-44 cont.

[16] For more information on EMFAC2011 and to download modeling materials, *see* http://www.arb.ca.gov/msei/modeling.htm.

[17] For more information on CARB's off-road model, *see* http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

[18] Information about OFFROAD2007 and the pending in-use agricultural sector model can also be found at http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

above 750 HP. The resulting inventories are presented in Tables 1 and 2 for calendar years 2015 and 2020, respectively.

Table 1

2015 Heavy-Duty NOx Emission Inventories for the South Coast and San Joaquin Valley Air Basins (tons per day)

Air Basin	On-Road		Construction		Agricultural		Total
	Older	NTDE	Older	NTDE	Older	NTDE	
South Coast	117.27	14.91	24.04	0.42	3.92	0.26	160.82
San Joaquin	83.07	15.44	11.85	0.21	26.73	1.86	139.16

Table 2

2020 Heavy-Duty NOx Emission Inventories for the South Coast and San Joaquin Valley Air Basins (tons per day)

Air Basin	On-Road		Construction		Agricultural		Total
	Older	NTDE	Older	NTDE	Older	NTDE	
South Coast	66.53	28.44	20.0	1.8	2.2	0.5	119.47
San Joaquin	32.13	30.33	11.5	1.0	15.0	3.8	93.76

ADF B3-44 cont.

Tables 1 and 2 show that vehicles with NTDEs account for only about 10% of NOx emissions in 2015 and between 25% and 40% of NOx emissions in 2020. Therefore, even if the CARB staff's assertion that biodiesel does not increase emissions from NTDEs were correct, the majority of NOx emissions would still be coming from older engines where, it has been clearly demonstrated, NOx emissions increase with the use of higher biodiesel blends. Applying the estimated NOx increases developed from the available emissions data analyzed by CARB staff (*see* Lyons Decl. ¶ 9, Table 1), and assuming more realistically and conservatively (as CEQA requires) that NTDEs will be affected by biodiesel in the same way as other engines, the overall increases in NOx emissions caused by biodiesel use will be (i) between 0.7 and 1.6 tons per day

in 2015 and between 0.5 and 1.2 tons per day in 2020 in the South Coast, and (ii) between 0.6 and 1.4 tons per day in 2015 and between 0.4 and 0.9 tons per day in 2020 in the San Joaquin Valley.

ADF B3-44 cont.

One way to put the magnitude of these potential increases in NOx emissions into context is to compare them with the air quality significance thresholds applied by the South Coast Air Quality Management District[19] and the San Joaquin Valley Air Pollution Control District[20] when evaluating the potential emission impacts of proposed projects in their jurisdictions. In the San Joaquin Valley Air Pollution Control District, the threshold is 10 tons per year while in the South Coast basin, the threshold is 0.0275 tons per day which equals 10 tons per year if daily emissions occurring over the course of the year are equal. The potential 2015 emission increases from the use of five percent biodiesel blends in the South Coast and the San Joaquin Valley are ***25 to 60 times higher*** than the 10-ton-per-year threshold. Even with reductions in diesel NOx emissions by 2020, the potential NOx increases due to biodiesel remains ***15 to 40 times higher*** than the 10-ton-per-year threshold. Potential increases of NOx emissions on such a scale require mitigation at the time and in the place where they will occur. *See POET*, 218 Cal. App. 4th at 740 (under CEQA, "ARB must adopt mitigation measures that minimize the adverse impact" of a potential increase in NOx emissions). Moreover, despite the fact that increases of NOx emissions resulting from the proposed ADF regulation would significantly exceed thresholds adopted by the South Coast Air Quality Management District and the San Joaquin Valley Air Pollution Control District, the ISOR fails to analyze whether the proposed ADF regulation has the potential to conflict with, or obstruct, applicable air quality plans.

ADF B3-45

[19] *See* http://www.aqmd.gov/ceqa/handbook/signthres.pdf.

[20] *See* http://www.valleyair.org/transportation/CEQA%20Rules/GAMAQI%20Jan%202002%20Rev.pdf.

There is no question that an increase in biodiesel usage will occur as a result of the LCFS regulation, a measure adopted under the Global Warming Solutions Act. *See POET*, 218 Cal. App. 4th at 700-01. Consequently, under not only CEQA, but also the Global Warming Solutions Act, CARB cannot permit emissions increases from biodiesel of such a magnitude when both the South Coast Air Quality Management District's 2012 Air Quality Management Plan[21] and the San Joaquin Valley's 2013 One Hour Ozone Plan[22] contain control measures intended to reduce NOx emissions by amounts of about the same magnitude as the potential emission increases resulting from biodiesel use at the five percent level. *See* Cal Health & Safety Code § 38562(b)(4) (greenhouse gas control measures such as the LCFS regulation are not to "interfere with ... efforts to achieve and maintain federal and state ambient air quality standards.").

ADF B3-45

IV. CONCLUSION

For the reasons explained above and in the reports and analyses accompanying these Comments, CARB cannot lawfully approve the proposed ADF regulation at this week's public hearing. CARB cannot commit itself now to the proposed ADF regulation and adjourn the important task of environmental assessment to a post hoc process. The available emissions data do not support, and indeed refute, the CARB staff's claim that low-level biodiesel blends are benign. Mitigation is required, and is required at the time and in the places where the NOx emissions increases can be expected to occur. If CARB directs the staff to make straightforward changes in the proposed ADF regulation in a timely manner that will require feasible mitigation

ADF B3-46

[21] *See* South Coast Air Quality Management District, 2012 Air Quality Management Plan, 2012 AQMP CARB/EPA/SIP Submittal (Dec. 2012) (available at http://www.aqmd.gov/aqmp/2012aqmp/Final/index.htmI).

[22] *See* http://www.valleyair.org/Air_Quality_Plans/Ozone-OneHourPlan-2013.htm.

measures, there will be no jeopardy to any program objective of the Global Warming Solutions Act or any other CARB project.

Respectfully submitted,

GROWTH ENERGY

3_B_ADF_GE Responses (Page 141 – 166)

145. Comment: **ADF B3-20, ADF B3-20, ADF B3-24, ADF B3-31, ADF B3-32, ADF B3-34, ADF B3-43 through ADF B3-46**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

146. Comment: **ADF B3-11**
The comment states that ARB staff excluded some feasible methods of NOx mitigation in the ADF proposal and goes on to claim that the public release of test data and analysis was incomplete.

Agency Response:
The comment is specific to the 2013 proposal. Relevant changes have been made and are reflected in the current proposal and all of ARB's test data and analysis has been made available to the public.

147. Comment: **ADF B3-12**
The commenter states that flaws in the proposal can be readily addressed through their preferred mitigation measures.

Agency Response:
The comment is specific to the 2013 proposal. Relevant changes have been made and are reflected in the 2015 proposal, which contains feasible NOx control measures for biodiesel. The development of the ADF regulation involved full public participation, which is highly encouraged during all ARB rulemaking activities.

148. Comment: **ADF B3-13**
The comment requests an update to the NOx "significance level."

Agency Response:
The comment is specific to the 2013 proposal, and is no longer relevant. The provisions discussed are not in the 2015 ADF regulation. To the extent that further information provides clarity on the path, ARB staff conducted a statistical analysis on the provisions of the ADF regulation, which can be found in Chapter 6 of the ADF Staff Report, and a supplemental analysis in Appendix G of the same document. Additionally, a statistical summary appears in **ADF 8-1**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

149. Comment: **ADF B3-15**
The comment urges the Board to ensure that all comments and data received in regards to the ADF proposal be placed in the rulemaking file.

Agency Response:
Please see the responses to **ADF 5-3** and **ADF 17-11.** .

150. Comment: **ADF B3-18**
This comment makes an argument for a different regulatory approach.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed no longer exist in the 2015 ADF regulation.

151. Comment: **ADF B3-19**
The comment states that analysis shows that NOx emissions increases exist for blends at or below the B10 level.

Agency Response:
In response to this comment on the 2013 proposal, ARB staff performed additional testing. Results and subsequent analysis has led to revised findings reflected in the current regulation. For information on the statistical analysis performed by staff, see response **ADF 17-6**, located in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

152. Comment: **ADF B3-21**
The comment states that ARB staff did not provide support to their NOx emissions conclusion.

Agency Response:
In response to the comment, ARB staff performed additional testing. Results and subsequent analysis has led to revised findings from the 2013 proposal. For information on the statistical analysis performed by staff, see response **ADF 8-1**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

153. Comment: **ADF B3-22**
The comment states that there is evidence that biodiesel increases NOx emissions in some engines.

Agency Response:
In response to the comment, ARB staff performed additional testing. Results and subsequent analysis has led to revised findings from the

2013 proposal. For information on the statistical analysis performed by staff, see response **ADF 8-1** in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."**.**

154. Comment: **ADF B3-23**
The comment states that NOx emissions have a statistically significant increase at the B5 blend level.

Agency Response:
ARB staff performed additional testing. Results and subsequent analysis led to revised findings from the 2013 proposal. For information on the statistical analysis performed by staff, see response **ADF 8-1** in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations." Additionally, see response **ADF 17-4** in the same document.

155. Comment: **ADF B3-25**
The comment questions the "threshold of significance" which ARB staff used.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed no longer exist in the 2015 ADF regulation.

156. Comment: **ADF B3-26**
The comment questions the use of the Effective Blend level concept proposed by ARB staff.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed no longer exist in the 2015 ADF regulation.

157. Comment: **ADF B3-27**
The comment questions the validity of the Effective Blend level equation.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed no longer exist in the 2015 ADF regulation.

158. Comment: **ADF B3-28**
The comment questions the capacity of the Effective Blend level calculation to mitigate NOx increase, particularly at a regional level.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed no longer exist in the 2015 ADF regulation.

159. Comment: **ADF B3-29**
The comment states that the Effective Blend level concept violates CEQA.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed no longer exist in the 2015 ADF regulation.

160. Comment: **ADF B3-30**
The comment states that the data used to support NOx-mitigating NTDEs is insufficient.

Agency Response:
The comment is specific to the 2013 ADF proposal, and no longer relevant. However, in development of the 2015 ADF regulation, ARB staff completed a thorough technical review of the emissions impact of biodiesel in NTDEs. For more information, please see response **ADF 17-4**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations.", concerning New Technology Diesel Engines.

161. Comment: **ADF B3-33**
The comment discusses costs of mitigation being passed to the end user and posits that absorption of these costs by regulated entities and end-users is appropriate.

Agency Response:
The ADF regulation has no specific provisions regarding whether the costs of compliance are absorbed by regulated entities or passed on to consumers. If biodiesel blends are used that require in-use requirements or other methods of compliance with the ADF regulation, the costs associated with compliance would be paid by the regulated entities, and may ultimately be passed on to consumers.

162. Comment: **ADF B3-35**
The comment states that reporting blend level on every gallon of biodiesel sold in the State is not as excessive as staff claimed and is similar to reporting conducted in LCFS.

Agency Response:
The comment is specific to the 2013 ADF proposal, and is no longer relevant. The provisions discussed are not in the 2015 ADF regulation.

163. Comment: **ADF B3-36**
The comment suggests modifications to the reporting requirements of the ADF proposal.

Agency Response:
Regarding biodiesel reporting parties: The 2015 ADF reporting requirements have been revised, including 15-day changes, to provide additional clarification for biodiesel reporting parties. Some fuel volumes reported under LCFS LRT may be also used for ADF reporting requirement. However, not all fuel producers are reporting parties under LRT. In addition, blended biodiesel reporting is not required under LRT. The ADF regulation contains reporting provisions that are applicable to not only fuel producers, but also all downstream fuel handlers where they report NOx control method, volumes, and blend level produced and sold.

164. Comment: **ADF B3-37**
The comment suggests modifications to the reporting requirements of the ADF regulation.

Agency Response:
Please see response **ADF B3-36.**

165. Comment: **ADF B3-38**
The comment from 2013 asserts that ARB has failed to include all communications received of a factual nature, and data that it has acquired, in the rulemaking file, and cites the lack of two examples of documents that should be in the record: a September 16, 2013 comment letter from Growth Energy, and certain data from the Durbin emissions studies.

Agency Response:
The September 16, 2013 letter was workshop feedback that pre-dates ARB's Notice of Public Hearing for the ADF regulation by more than 15 months. (An earlier rulemaking process was initiated in a separate notice published October 25, 2013, but that proposal was withdrawn in early 2014 and eventually replaced with this proposal.) The Notice of Public Hearing for the current ADF proposal, which formally

commenced the rulemaking process, contained the following statement:

All written comments, data, factual information, studies, and reports submitted to ARB during the public comment period or at the Board hearing will be included in the rulemaking file for the proposed regulation. *Any person who provided ARB with written feedback or other materials prior to the opening of the public comment period must submit the feedback or materials during the public comment period or at the hearing to have them included in the rulemaking file.* [Emphasis added.]

Growth Energy availed itself of this invitation to include many of its pre-rulemaking letters in the public record, and could have done the same with its September 16, 2013 letter if it chose to do so. ARB posted this letter and other workshop feedback on ADF on ARB's website at http://www.arb.ca.gov/fuels/diesel/altdiesel/meetings/20130916GrowthEnergyinput.pdf.

For a response to the comment that not all Durbin emissions study data was placed into the rulemaking file, see response **ADF B3-20**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

166. Comment: **ADF B3-39**
The comment from 2013 states that feedback letters received by ARB in response to pre-rulemaking workshops should have been included in the rulemaking record by October 15, 2013, the date of the Notice of Public Hearing for the first ADF proposal that was subsequently withdrawn by ARB.

Agency Response:
Please see the discussion about Growth Energy's September 16, 2013 letter in response **ADF B3-38**, above, which contains a response to **ADF B3-20**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

167. Comment: **ADF B3-40**
The comment from 2013 states that ARB must ensure compliance with Government Code section 11347.3 (impliedly by adding workshop feedback letters to the rulemaking file) and re-issue a notice of proposed rulemaking to allow for 45 days of comment prior to the hearing.

Agency Response:
ARB believes it complied with section 11347.3 in compiling the

rulemaking file for the current ADF proposal. See also the discussion about Growth Energy's September 16, 2013 letter in the response **ADF B3-38**, which also contains a reference to **ADF B3-20**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

168. Comment: **ADF B3-41**
The comment from 2013 states that ARB cannot take action on the proposed ADF regulation until it evaluates environmental issues for itself, consistent with CEQA and ARB regulations. The comment also says 45 days is not an adequate period for public comment, in part because not all relevant data was publicly released.

Agency Response:
An entirely new Environmental Analysis was prepared in for the current ADF and LCFS proposals than what was provided at the time of the comment, so it is not clear that the comment is applicable to the current rulemakings and their environmental analysis. But assuming the comment applies to the current ADF rulemaking process and documentation, ARB disagrees with the comment. The Board will consider the Environmental Analysis prepared for the ADF and LCFS proposals before it considers adoption of the two regulations. The Environmental Analysis and supporting documentation were provided to the public and identified in references for the Environmental Analysis, and also included in the rulemaking files for the ADF and LCFS regulations. Finally, the 45-day comment period complies with ARB's certified regulatory program (see Cal. Code Regs., tit. 17, § 60005, subd. (a)) and is also consistent with the public review period that CEQA provides for a draft environmental impact report (see Cal. Code Regs., tit. 14, § 15101, subd. (a)), although the CEQA provision does not apply to the draft Environmental Analysis.

169. Comment: **ADF B3-42**
The comment from 2013 raises procedural objections to the Board taking action on the ADF regulation at the hearing scheduled for December 12-13, 2013.

Agency Response:
The objections do not apply to the Board's action in 2015 to approve the ADF. The Board will consider adopting the ADF regulation after it considers the final Environmental Analysis and responses to environmental comments. ARB also assembled and made available a complete rulemaking file, and responded to public comments received.

EXHIBIT A

NOx Emissions Impact of Soy- and Animal-based Biodiesel Fuels: A Re-Analysis

December 10, 2013

Prepared for:

Sierra Research
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NOX EMISSIONS IMPACT OF SOY- AND ANIMAL-BASED BIODIESEL FUELS: A RE-ANALYSIS

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NOX IMPACT OF SOY- AND ANIMAL-BASED BIODIESEL FUELS: A RE-ANALYSIS

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1. EXECUTIVE SUMMARY

1.1 Background on the Proposed Rule

The California Air Resources Board (CARB) has proposed regulations on the commercialization of alternative diesel fuel (ADF) that were to be heard at the December 2013 meeting of the Board. The proposed regulations seek to "... create a streamlined legal framework that protects California's residents and environment while allowing innovative ADFs to enter the commercial market as efficiently is possible."[1] In this context ADF refers to biodiesel fuel blends. Biodiesel fuels are generally recognized to have the potential to decrease emissions of several pollutants, including hydrocarbons (HC), carbon monoxide (CO), and particulate matter (PM), but are also recognized to have the potential to increase oxides of nitrogen (NOx) unless mitigated in some way. NOx emissions are an important precursor to smog and have historically been subject to stringent emission standards and mitigation programs to prevent growth in emissions over time. A crucial issue with respect to biodiesel is how to "... safeguard against potential increases in oxides of nitrogen (NOx) emissions."[2]

The proposed regulations are presented in the Staff Report: Initial Statement of Reasons (ISOR) for the Proposed Regulation on the Commercialization of New Alternative Diesel Fuels[3] (referenced as ISOR). Chapter 5 of the document describes the proposed regulations, which exempt diesel blends with less than 10 percent biodiesel (B10) from requirements to mitigate NOx emissions:

> There are two distinct blend levels relative to biodiesel that have been identified as important for this analysis. Based on our analysis to date, we have found that diesel blends with less than 10 percent biodiesel by volume (<B10) have no significant increase in any of the pollutants of concern and therefore will be regulated at Stage 3B (Commercial Sales not Subject to Mitigation). However, we have found that biodiesel blends of 10 percent and above (≥B10) have potentially significant increases in NOx emissions, in the absence of any mitigating factors, and therefore those higher blend levels will be regulated under Stage 3A (Commercial Sales Subject to Mitigation).[4]

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[1] "Notice of Public Hearing to Consider Proposed Regulation on the Commercialization of New Alternative Diesel Fuels." California Air Resources Board, p. 3. http://www.arb.ca.gov/regact/2013/adf2013/adf2013notice.pdf.

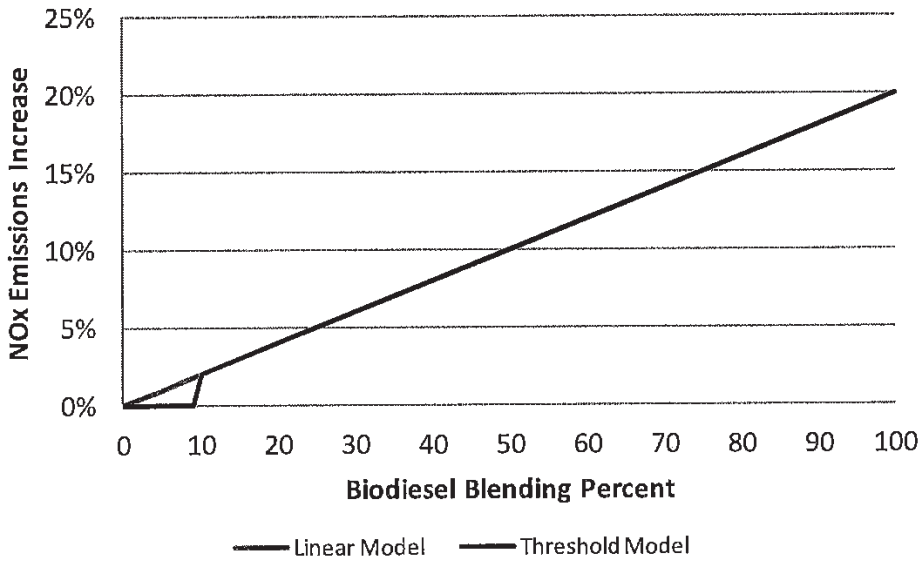
[2] Ibid. p. 3.

[3] "Proposed Regulation on the Commercialization of New Alternative Diesel Fuels. Staff Report: Initial Statement of Reason." California Air Resources Board, Stationary Source Division, Alternative Fuels Branch. October 23, 2013. http://www.arb.ca.gov/regact/2013/adf2013/adf2013isor.pdf.

[4] Ibid, p. 22.

Existing research on the NOx emission effects of biodiesel has consistently been conducted under the hypothesis that the emission effect will be linearly proportional to the blending percent of neat biodiesel (B100) with the base diesel fuel. The Linear Model that has been accepted by researchers is shown as the blue line in Figure 1-1. The Staff position cited above is that biodiesel fuels do not increase NOx emissions until the fuel blend reaches 10% biodiesel. This so-called Staff Threshold Model departs from the Linear Model that underlies past and current biodiesel research by claiming that NOx emissions do not increase until the biodiesel content reaches 10 percent.

Figure 1-1
Linear and Staff Threshold Models for Biodiesel NOx Impacts



The Staff Threshold model is justified by the statement: "Based on our analysis to date, we have found that diesel blends with less than 10 percent biodiesel by volume (<B10) have no significant increase in any of the pollutants of concern." Other portions of the ISOR state that Staff will track "... the effective blend level on an annual statewide average basis until the effective blend level reaches 9.5 percent. At that point, the biodiesel producers, importers, blenders, and other suppliers are put on notice that the effective blend-level trigger of 9.5 percent is approaching and mitigation measures will be required once the trigger is reached."[5] Until such time, NOx emission increases from biodiesel blends below B10 will not require mitigation.

Section 6 of the ISOR presents a Technology Assessment that includes a literature search the Staff conducted to obtain past studies on the NOx impact of biodiesel in heavy-duty

ADF B3-46 cont.

ADF B3-47

[5] Ibid, p. 24.

engines using California diesel (or other high-cetane diesel) as a base fuel. Section 6.d presents the results of the literature search with additional technical information provided in Appendix B. The past studies include the Biodiesel Characterization and NOx Mitigation Study[6] sponsored by CARB (referenced as Durbin 2011).

The results of the Staff literature search are summarized in Table 1-1, which has been reproduced from Table 6.1 of the ISOR. For B5 and B20, the data represent averages for a mix of soy- and animal-based biodiesels, which tend to have different impacts on NOx emissions (animal-based biodiesels increase NOx to a lesser extent). For B10, the data represent an average for soy-based biodiesels only. Staff uses the +0.3% average NOx increase at B5 in comparison to the 1.3% standard deviation to conclude:

> Overall, the testing indicates different NOx impacts at different biodiesel percentages. Staff analysis shows there is a wide statistical variance in NOx emissions at biodiesel levels of B5, providing no demonstrable NOxemissions impact at this level and below. Atbiodiesel levels of B10 and above, multiple studies demonstrate statistically significant NOx increases, without additional mitigation.[7]

Table 1-1
Results of Literature Search Analysis

Biodiesel Blend Level	NOx Difference	Standard Deviation
B5	0.3%	1.3%
B10[a]	2.7%	0.2%
B20	3.2%	2.3%

Source: Table 6.1 of Durbin 2011
Notes:
[a] Represents data using biodiesel from soy feedstocks.

ADF B3-47 cont.

The Staff conclusion is erroneous because it relies upon an apples-to-oranges comparison among the blending levels. Each of the B5, B10, and B20 levels include data from a different mix of studies, involving different fuels (soy- and/or animal-based), different test engines, and different test cycles. The B5 values come solely from the CARB Biodiesel Characterization study, while the B10 values come solely from other studies. The B20 values are a mix of data from the CARB and other studies. The results seen in the table above are the product of the uncontrolled aggregation of different studies that produces incomparable estimates of the NOx emission impact at the three blending levels.

[6] "CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California: Biodiesel Characterization and NOx Mitigation Study." Prepared by Thomas D. Durbin, J. Wayne Miller and others. Prepared for Robert Okamoto and Alexander Mitchell, California Air Resources Board. October 2011.
[7] ISOR, p. 32.

As will be demonstrated in this report, the Staff conclusion drawn from the data in Table 1-1 is not supported by past or current biodiesel research, including the recent testing program sponsored by CARB. In fact, past and current studies indicate that biodiesel blends at any level will increase NOx emissions in proportion to the blending percent unless specifically mitigated by additives or other measures.

ADF B3-47 cont.

1.2 Summary and Conclusions

The following sections of this report examine the studies cited by CARB one-by-one. As evidenced from this review, it is clear that the data do not support the Staff conclusion and, indeed, the data refute the Staff conclusion in some instances. Specifically:

- There is no evidence supporting the Staff conclusion that NOx emissions do not increase until the B10 level is reached. Instead, there is consistent and strong evidence that biodiesel increases NOx emissions in proportion to the biodiesel blending percent. ADF B3-48

- There is clear and statistically significant evidence that biodiesel increases NOx emissions at the B5 level in at least some engines for both soy- and animal-based biodiesels. ADF B3-49

Considering each of the six past studies obtained from the technical literature and their data on high-cetane biodiesels comparable to California fuels, we find the following:

1. None of the six studies measured the NOx emissions impact from biodiesel at blending levels below B10. Only two studies tested a fuel at the B10 level. All other testing was at the B20 level or higher. Because none tested a B5 (or similar) fuel, none of them can provide direct evidence that NOx emissions are not increased at B5 or other blending levels below B10. ADF B3-50

2. These studies provide no data or evidence supporting the validity of the Staff's Threshold Model that biodiesel below B10 does not increase NOx emissions. In fact, all of the studies are consistent with the contention that biodiesel increases NOx emissions in proportion to the blending percent. ADF B3-51

3. Two of the studies present evidence and arguments that the NOx impact from biodiesel is a continuous effect that is present even at very low blending levels and will increase at higher levels in proportion to the blending percentage. ADF B3-52

Considering the CARB Biodiesel Characterization report, we find that:

4. For the three engines where CARB has published the emission values measured in engine dynamometer testing, all of the data demonstrate that biodiesel fuels significantly increase NOx emissions for both soy- and animal-based fuels by amounts that are proportional to the blending percent. This is true for on-road and off-road engines and for a range of test cycles. ADF B3-53

5. Where B5 fuels were tested for these engines, NOx emissions were observed to increase. NOx emission increases are smaller at B5 than at higher blending levels and the observed increases for two engines were not statistically significant by themselves based on the pair-wise t-test employed in Durbin 2011.[8] However, the testing for one of the engines (the 2007 MBE4000) showed statistically significant NOx emission increases at the B5 level for both soy- and animal-based blends.

ADF B3-54

By itself, the latter result is sufficient to disprove the Staff's contention that biodiesel blends at the B5 level will not increase NOx emissions.

Based on examination of all of the studies cited by CARB as the basis for its proposal to exempt biodiesels below B10 from mitigation, it is clear that the available research points to the expectation that both soy- and animal-based biodiesel blends will increase NOx emissions in proportion to their biodiesel content, including at the B5 level. CARB's own test data demonstrate that B5 will significantly increase NOx emissions in at least some engines.

ADF B3-55

Based on data in the CARB Biodiesel Characterization report, soy-based biodiesels will increase NOx emissions by about 1% at B5 (and 2% at B10), while animal-based biodiesels will increase NOx emissions by about one-half as much: 0.45% at B5 (and 0.9% at B10). All of the available research says that the NOx increases are real and implementation of mitigation measures will be required to prevent increases in NOx emissions due to biodiesel use at blending levels below B10.

ADF B3-56

Finally, we note that CARB has not published fully the biodiesel testing data that it relied on in support of the Proposed Rule and thereby has failed to adequately serve the interest of full public disclosure in this matter. The CARB-sponsored testing reported in Durbin 2011 is the sole source of B5 testing cited by CARB as support for the Proposed Rule. Durbin 2011 publishes only portions of the measured emissions data in a form that permits re-analysis; it does not publish any of the B5 data in such a form. It has not been possible to obtain the remaining data through a personal request to Durbin or an official public records request to CARB and, to the best of our knowledge, the data are not otherwise available online or through another source.

ADF B3-57

CARB should publish all of the testing presented in Durbin 2011 and any future testing that it sponsors in a complete format that allows for re-analysis. Such a format would be (a) the measured emission values for each individual test replication; or (b) averages across all test replications, along with the number of replications and the standard error of the individual tests. The first format (individual test replications) is preferable because that would permit a full examination of the data including effects such as test cell drift over time. Such publication is necessary to assure that full public disclosure is achieved and that future proposed rules are fully and adequately informed by the data.

ADF B3-58

[8] As discussed in Section 3.3, the pair-wise t-test is not the preferred method for demonstrating statistical significance.

1.3 Review of 2013 CARB B5 Emission Testing

In December 2013, after the release of the ISOR and in response to an earlier Public Records Act request, CARB released a copy of new CARB-sponsored emission testing conducted by Durbin and others at the University of California CE-CERT[9]. The purpose of the study was "... to evaluate different B5 blends as potential emissions equivalent biodiesel fuel formulations for California."[10] Three B5 blends derived from soy, waste vegetable oil (WVO), and animal biodiesel stocks were tested on one 2006 Cummins ISM 370 engine using the hot-start EPA heavy-duty engine dynamometer cycle. A preliminary round of testing was conducted for all three fuels followed by emissions-equivalent certification testing per 13 CCR 2282(g) for two of the fuels. As noted by Durbin: "[t]he emissions equivalent diesel certification procedure is robust in that it requires at least twenty replicate tests on the reference and candidate fuels, providing the ability to differentiate small differences in emissions."[11]

Soy and WVO B5 Biodiesel

The B5-soy and B5-WVO fuels were blended from biodiesel stocks that were generally similar to the soy-based stock used in the earlier CARB Biodiesel Characterization Study (Durbin 2011) with respect to API gravity and cetane number. In the preliminary testing, the two fuels "...showed 1.2-1.3% statistically significant [NOx emissions] increases with the B5-soy and B5-WVO biodiesel blends compared to the CARB reference fuel."[12] The B5-WVO fuel caused the smaller NOx increase (1.2%) and was selected for the certification phase of the testing. There, it "... showed a statistically significant 1.0% increase in NOx compared to the CARB reference fuel"[13] and failed the emissions-equivalent certification due to NOx emissions.

ADF B3-59

Animal B5 Biodiesel

The B5-animal derived fuel was blended from an animal tallow derived biodiesel that was substantially different from the animal based biodiesel used in the earlier Durbin study, and was higher in both API gravity and cetane number. The blending response for cetane number was also surprising, in that blending 5 percent by volume of a B100 stock (cetane number 61.1) with 95% of CARB ULSD (cetane number 53.1) produced a B5 fuel blend with cetane number 61.

ADF B3-60

In preliminary testing, the B5-animal fuel showed a small NOx increase which was not statistically significant, causing it to be judged the best candidate for emissions-equivalent certification. In the certification testing, it "...showed a statistically

ADF B3-61

[9] "CARBB5 Biodiesel Preliminary and Certification Testing." Prepared by Thomas D. Durbin, G. Karavalakis and others. Prepared for Alexander Mitchell, California Air Resources Board. July 2013. This study is not referenced in the ISOR, nor was it included in the rule making file when the hearing notice for the ADF regulation was published in October 2013.
[10] Ibid, p. vi.
[11] Ibid, p. viii.
[12] Ibid, p. 8.
[13] Ibid, p. 9.

significant 0.5% reduction in NOx compared to the CARB reference fuel"[13] and passed the emissions-equivalent certification. The NOx emission reduction for this fuel blend appears to be real for this engine, but given the differences between the blendstock and the animal based biodiesel blendstock used in the earlier Durbin study it is unclear that it is representative for animal-based biodiesels in general..

ADF B3-61 cont.

Summary

The conclusions drawn in the preceding section are not changed by the consideration of these new emission testing results. For plant-based biodiesels (soy- and WVO-based), the new testing provides additional and statistically significant evidence that B5 blends will increase NOx emissions at the B5 level. The result of decreased NOx for the B5 animal-based blend stands out from the general trend of research results reviewed in this report. However:

- The same result – reduced NOx emissions for some fuels and engines – has sometimes been observed in past research, as evidenced by the emissions data considered by CARB staff in ISOR Figure B.3 (reproduced in Figure 2.1 below). As shown, some animal-based B5 and B20 fuels reduced NOx emissions while others increased NOx emissions with the overall conclusion being that NOx emissions increase in direct proportion to biodiesel content of the blends and that there is no emissions threshold.

- Increasing cetane is known to generally reduce NOx emissions and has already been proposed by CARB as a mitigation strategy for increased NOx emissions from biodiesel[14]. The unusual cetane number response in the blending and the high cetane number of the B5-animal fuel may account for the results presented in the recently released study.

ADF B3-62 cont.

Considering the broad range of plant- and animal-based biodiesel stocks that will be used in biodiesel fuels, we conclude that the available research (including the recently released CARB test results) indicates that unrestricted biodiesel use at the B5 level will cause real increases in NOx emissions and that countermeasures may be required to prevent increases in NOx emissions due to biodiesel use at blending levels below B10.

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[14] For example, see Durbin 2011 Section 7.0 for a discussion of NOx mitigation results through blending of cetane improvers and other measures.

2. CARB LITERA TURE REVIEW

The Staff ISOR explains that the Appendix B Technology Assessment is the basis for CARB's conclusion that biodiesels below B10 have no significant impact on NOx emissions. The assessment is based on data from seven studies (identified in Table 2-1) that tested high-cetane diesel fuels. The first study (Durbin 2011) is the Biodiesel Characterization Study that was conducted for CARB, while the others were obtained through a literature search.

Tab le 2-1
List of Studies f rom High-Cetane Liter ature Sear ch

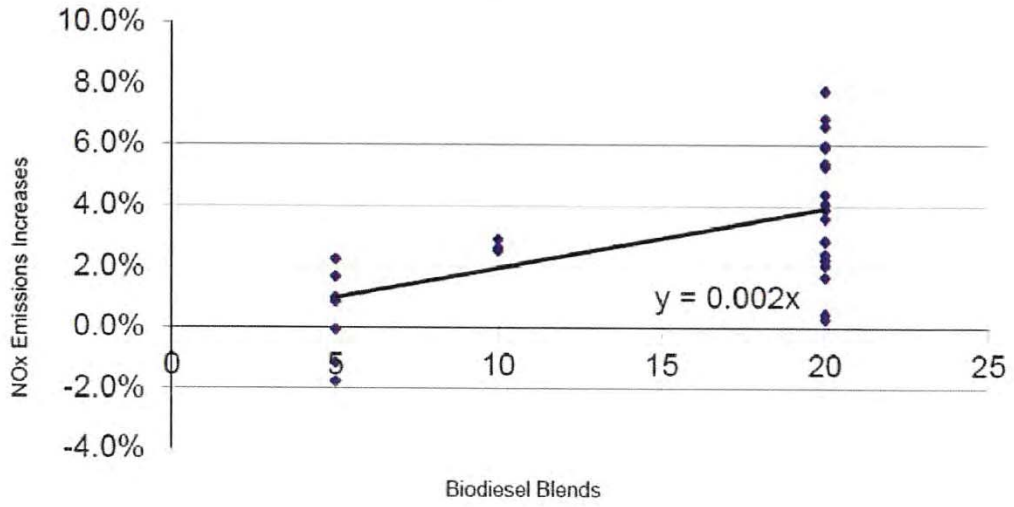
Primary Author	Title	Published	Year
Durbin	Biodiesel Mitigation Study	Final Report Prepared for Robert Okamoto, M.S. and Alexander Mitchell, CARB	2011
Clark	Transient Emissions Comparisons of Alternative Compression Ignition Fuel	SAE 1999-01-1117	1999
Eckerle	Effects of Methyl Ester Biodiesel Blends on NOx Emissions	SAE 2008-01-0078	2008
McCormick	Fuel Additive and Blending Approaches to Reducing NOx Emissions from Biodiesel	SAE 2002-01-1658	2002
McCormick	Regulated Emissions from Biodiesel Tested in Heavy-Duty Engines Meeting 2004 Emissions	SAE 2005-01-2200	2005
Nuszkowski	Evaluation of the NOx emissions from heavy duty diesel engines with the addition of cetane improvers	Proc. I Mech E Vol. 223 Part D: J. Automobile Engineering, 223, 1049-1060	2009
Thompson	Neat fuel influence on biodiesel blend emissions	Int J Engine Res Vol. 11, 61-77.	2010

Source: Table B.2 of Durbin 2011

Figure 2-1 reproduces two exhibits from Appendix B that show increasing trends for NOx emissions with the biodiesel blending level. Based on the slopes of the trend lines,

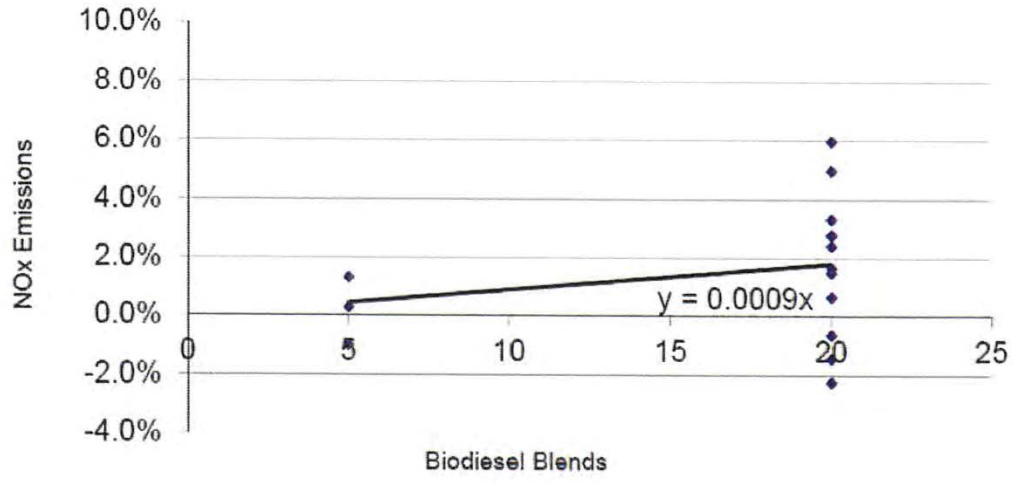
Figure 2-1
NOx Emission Increases Observed in Biodiesel Research Cited in Staff ISOR

Figure B.2: NOx Impact of Soy Biodiesel Blended in High Cetane Base Fuel



ADF B3-63

Figure B.3: NOx Impact of Animal Biodiesel Blended in High Cetane Base Fuel



Source: Figures B.2 and B.3 of Appendix B: Technology Assessment

soy-based biodiesels are shown to increase NOx emissions by approximately 1% at B5, 2% at B10, and 4% at B20. Animal-based biodiesels are shown to increase NOx emissions by about one-half as much: 0.45% at B5, 0.9% at B10, and 1.8% at B20. Although there is substantial scatter in the results, these data do not appear to support the Staff Threshold Model that biodiesel does not increase NOx emissions at B5 but does so at B10.

ADF B3-63 cont.

We will examine the Durbin 2011 study at some length in Section 3. In this section, we look at each of the other studies cited by the Staff to find out what the studies say about NOx emissions impacts at and below B10.

2.1 Review of Literature Cited in the ISOR

The Staff literature search sought and selected testing that used fuels with cetane levels comparable to California diesel fuels; the Staff does not, however, list those fuels or provide the data that support the tables and figures in Appendix B of the ISOR. Therefore, we have necessarily made our own selection of high-cetane fuels in the course of reviewing the studies. The key testing and findings of each study are summarized below, with a specific focus on what they tell us about NOx emission impacts at B10 and below.

2.1.1 Clark 1999

This study tested a variety of fuels on a 1994 7.3L Navistar T444E engine. Of the high-cetane base fuels, one base fuel (Diesel A, off-road LSD) was blended and tested at levels of B20, B50, and B100. NOx emissions were significantly increased for all of the blends. The other base fuel (CA Diesel) was tested only as a base fuel. Its NOx emissions were 12% below that of Diesel A, making it is unclear whether Diesel A is representative of fuels in CA. This study conducted no testing of the NOx emissions impact from biodiesels at the B10 level or below.

2.1.2 Eckerle 2008

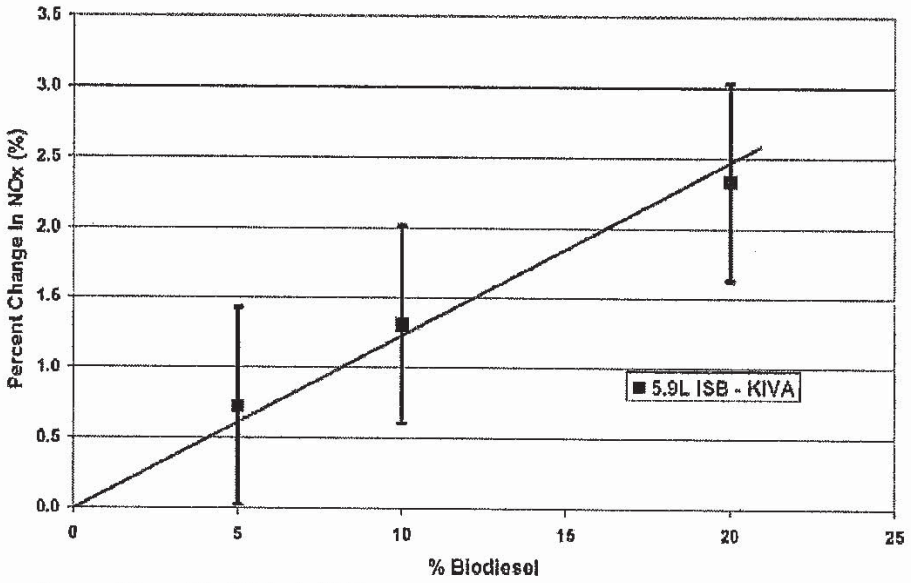
This study tested low and mid/high-cetane base fuels alone and blended with soy-based biodiesel at the B20 level. The Cummins single-cylinder test engine facility was used in a configuration representative of modern diesel technology, including cooled EGR. Testing was conducted under a variety of engine speed and load conditions. FTP cycle emissions were then calculated from the speed/load data points. The test results show that B20 blends increase NOx emissions compared to both low- and high-cetane base fuels. This study conducted no testing of the NOx emissions impact from biodiesels at the B10 level or below.

ADF B3-64

The study notes that two other studies "show that NOx emissions increase nearly linearly with the increase in the percentage of biodiesel added to diesel fuel." Eckerle's Figure 21 (reproduced below as Figure 2-2) indicates a NOx emissions increase at B5, which is the basis for the statement in the abstract that "Results also show that for biodiesel blends containing less than 20% biodiesel, the NOx impact over the FTP cycle is proportional to

the blend percentage of biodiesel." The authors clearly believe that biodiesel fuels have NOx emission impacts proportional to the blending percent at all levels including B5.

Figure 2-2
Impact of Biodiesel Blends on Percent NOx Change for the 5.9L ISB Engine Operation Over the FTP Cycle



Source: Figure 21 of Eckerle 2008

ADF B3-64 cont.

2.1.3 McCormick 2002

This study tested low- and mid-cetane base fuels alone and blended with soy- and animal-based biodiesel at the B20 level. The testing was conducted on a 1991 DDC Series 60 engine using the hot-start U.S. heavy-duty FTP. NOx emission increases were observed for both fuels at the B20 level. Mitigation of NOx impacts was investigated by blending a Fisher-Tropsch fuel, a 10% aromatics fuel and fuel additives. This study conducted no testing of the NOx emissions impact from commercial biodiesels at the B10 level or below.

This study also tested a Fisher-Tropsch (FT) base fuel blended at the B1, B20, and B80 levels. Although the very high cetane number (≥75) takes it out of the range of commercial diesel fuels, it is interesting to note that the study measured higher NOx emissions at the B1 level than it did on the FT base fuel and substantially higher NOx emissions at the B20 and B80 levels. While the B1 increase was not statistically significant given the uncertainties in the emission measurements (averages of three test runs), it is clear that increased NOx emissions have been observed at very low blending levels.

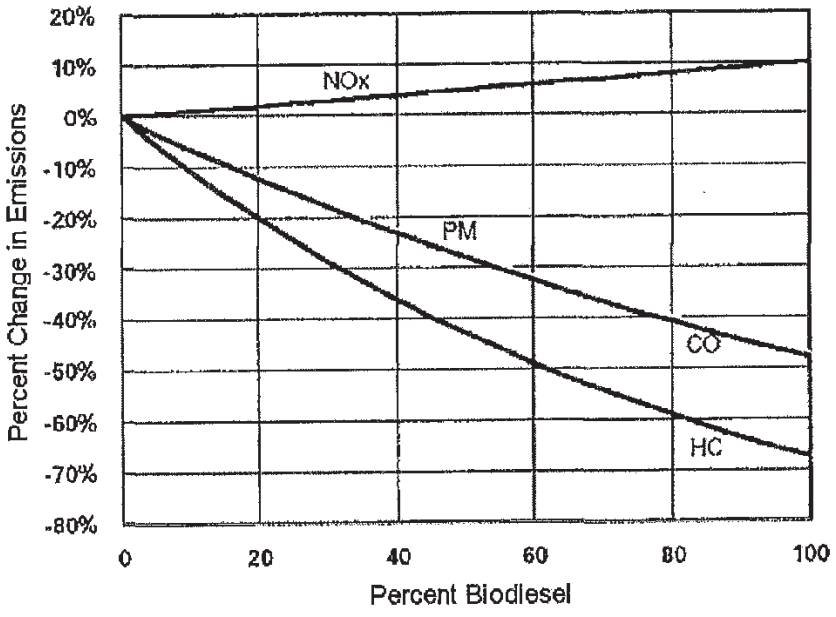
ADF B3-65

2.1.4 McCormick 2005

This study tested blends of soy- and animal-based biodiesels with a high-cetane ULSD base fuel at B10 levels and higher. Two engines were tested – a 2002 Cummins ISB and a 2003 DDC Series 60, both with cooled EGR. The hot-start U.S. heavy-duty FTP test cycle was used. The majority of testing was at the B20 level with additional testing at the B50 and B100 levels. One soy-based fuel was tested at B10. The study showed NOx emission increases at B10, B20, and higher levels. The study also investigated mitigation of NOx increases. This study conducted no testing of the NOx emissions impact from biodiesels below the B10 level.

The authors present a figure (reproduced as Figure 2-3) in their introduction that shows their summary of biodiesel emission impacts based on an EPA review of heavy-duty engine testing. It shows NOx emissions increasing linearly with the biodiesel blend percentage.

Figure 2-3
Trend in HC, CO, NOx and PM Emissions with Biodiesel Percent



Source: McCormick 2005

ADF B3-66

2.1.5 Nuszkowski 2009

This study tested five different diesel engines: one 1991 DDC Series 60, two 1992 DDC Series 60, one 1999 Cummins ISM, and one 2004 Cummins ISM. Only the 2004 Cummins ISM was equipped with EGR. All testing was done using the hot-start U.S. heavy-duty FTP test cycle. The testing was designed to test emissions from fuels with and without cetane-improving additives. Although a total of five engines were tested, the base diesel and B20 fuels were tested on only two engines (one Cummins and one DDC Series 60) because there was a limited supply of fuel available. NOx emissions increased on the B20 fuel for both engines. A third engine (Cummins) was tested on B20 and B20 blended with cetane improvers to examine mitigation of NOx emissions. This study conducted no testing of the NOx emissions impact from biodiesels at the B10 level or below.

ADF B3-67

2.1.6 Thompson 2010

This study examined the emissions impacts of soy-based biodiesel at the B10 and B20 levels relative to low-cetane (42), mid-cetane (49), and high-cetane (63) base fuels using one 1992 DDC Series 60 engine. The emissions results were measured on the hot-start U.S. heavy-duty FTP cycle. The study found that NOx emissions were unchanged (observed differences were not statistically significant) at B10 and B20 levels for the low- and mid-cetane fuels. NOx emissions increased significantly at B10 and B20 levels for the high-cetane fuels. This study conducted no testing of the NOx emissions impact from biodiesels at levels below B10.

ADF B3-68

2.2 Conclusions Based on Studies Obtained in Literature Search

From the foregoing summary of the studies cited by Staff, we reach the conclusions given below.

1. None of the six studies measured the NOx emissions impact from commercial-grade biodiesel at blending levels below B10, and only two studies tested a fuel at the B10 level. All other testing was at the B20 level or higher. Because none tested a B5 (or similar) fuel, none is capable of providing direct evidence regarding NOx emissions at B5 or other blending levels below B10.

ADF B3-69

2. These studies provide no data or evidence supporting the validity of Staff's Threshold Model that biodiesel below B10 does not increase NOx emissions. In fact, all of the studies are consistent with the contention that biodiesel increases NOx emissions in proportion to the blending percent.

ADF B3-70

3. Two of the studies present evidence and arguments that the NOx impact from biodiesel is a continuous effect that is present even at very low blending levels and will increase at higher levels in proportion to the blending percentage. One study tested a Fischer-Tropsch biodiesel blend at B1 and observed NOx emissions to increase (but not by a statistically significant amount).

ADF B3-71

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3. CARB BIODIESEL CHARACTERIZATION STUDY

3.1 Background

CARB sponsored a comprehensive study of biodiesel and other alternative diesel blends in order "... to better characterize the emissions impacts of renewable fuels under a variety of conditions."[15] The study was designed to test eight different heavy- duty engines or vehicles, including both highway and off-road engines using engine or chassis dynamometer testing. Five different test cycles were used: the Urban Dynamometer Driving Schedule (UDDS), the Federal Test Procedure (FTP), and 40 mph and 50 mph CARB heavy-heavy-duty diesel truck (HHDDT) cruise cycles, and the ISO 8178 (8 mode) cycle. Table 3-1 (reproduced from Table ES-1 of Durbin 2011) documents the scope of the test program. Because the Staff relied only on engine dynamometer testing in its Technology Assessment, only the data for the first four engines (shaded) are considered here.

Table 3-1
A Breakdown of the Test Engines for the Different Categories of Testing

2006 Cummins ISM[a]	Heavy-duty on-highway	Engine dynamometer	
2007 MBE4000	Heavy-duty on-highway	Engine dynamometer	
1998, 2.2 liter, Kubota V2203-DIB	Off-road	Engine dynamometer	
2009 John Deere 4.5 L	Off-road	Engine dynamometer	
2000 Caterpillar C-15	Heavy-duty on-highway	Chassis dynamometer	Freightliner chassis
2006 Cummins ISM	Heavy-duty on-highway	Chassis dynamometer	International chassis
2007 BME4000	Heavy-duty on-highway	Chassis dynamometer	Freightliner chassis
2010 Cummins ISX15	Heavy-duty on-highway	Chassis dynamometer	Kenworth chassis

Source: Table ES-1 of Durbin 2011, page xxvi
Notes:
[a] Data for the first four engines (shaded) are considered in this report.

[15] Durbin 2011, p. xxiv.

The original goal of this report was to subject all of the NOx emission testing in Durbin 2011 to a fresh re-analysis. However, it was discovered that Durbin 2011 did not report all of the data that were obtained during the program and are discussed in the report. The chassis dynamometer testing was conducted at the CARB Los Angeles facility. Emission results for the chassis dynamometer testing are presented in tabular and graphical form, but the report does not contain the actual emissions test data. For the engine dynamometer testing, some of the measured emission values are not reported even though the emission results are reported in tabulated or graphical form. Requests for the missing data were directed to Durbin in a personal request and to CARB through an official records request. No information has been provided in response and we have not been able to obtain the missing data from online or other sources.

ADF B3-72

For this report, we have worked with the data in the forms that are provided in Durbin 2011 as being the best-available record of the results of the CARB study. Because Staff used only data obtained in engine dynamometer testing, the analysis presented in this report has done the same. Nevertheless, the results of the chassis dynamometer testing are generally supportive of the results and conclusions presented here. Durbin 2011 notes:

> "... The NOx emissions showed a consistent trend of increasing emissions with increasing biodiesel blend level. These differences were statistically significant or marginally significant for nearly all of the test sequences for the B50 and B100 fuels, and for a subset of the tests on the B20 blends."[16]

Durbin notes that emissions variability was greater in the chassis dynamometer testing, which leads to the sometimes lower levels of statistical significance. There was also a noticeable drift over time in NOx emissions that complicated the results for one engine.

3.2 Data and Methodology

Table 3-2 compiles descriptive information on the engine dynamometer testing performed in Durbin 2011. The experimental matrix involves four engines, two types of biodiesel fuels (soy- and animal-based), and up to four test cycles per engine. However, the matrix is not completely filled with all fuels tested on all engines on all applicable test cycles. The most complete testing is for the ULSD base fuel and B20, B50, and B100 blends. There is less testing for the B5 blend, and B5 is tested using only a subset of cycles. For this reason, we first examine the testing for ULSD, B20, B50, and B100 fuels to determine the overall impact of biodiesels on NOx emissions. We then examine the more limited testing for B5 to determine the extent to which it impacts NOx emissions.

This examination is limited by the form in which emissions test information is reported in Durbin 2011. A complete statistical analysis can be conducted only for the two on-road engines for which Appendices G and H of Durbin 2011 provide measured emissions, and for a portion of the testing of the Kubota off-road engine for which Appendix I provides

[16] Durbin 2011, p. 126.

Table 3-2 Experimental Matrix for Heavy-Duty Engine Dynamometer Testing Reported in Durbin 2011				
Engine	Biodiesel Type	Fuels Tested	Test Cycles	Notes
On-Road Engines				
2006 Cummins ISM	Soy	ULSD, B20, B50, B100, B5	UDDS, FTP, 40 mph, 50 mph	B5 tested on 40 mph and 50 mph cruise cycles
	Animal	ULSD, B20, B50, B100, B5	UDDS, FTP, 50 mph	B5 tested only on FTP.
2007 MBE4000	Soy	ULSD, B20, B50, B100, B5	UDDS, FTP, 50 mph	B5 tested only on FTP.
	Animal	ULSD, B20, B50, B100, B5		B5 tested only on FTP.
Off-Road Engines				
1998 Kubota V2203-DIB	Soy	ULSD, B20, B50, B100, B5	ISO 8178 (8 Mode)	none
	Animal	Not tested		
2009 John Deere	Soy	ULSD, B20, B50, B100	ISO 8178 (8 Mode)	B5 not tested
	Animal	ULSD, B20, B5		none

measured emissions. The data needed to support a full re-analysis consist of measured emissions on each fuel in gm/hp-hr terms, which are stated in Durbin 2011 as averages across all test replications along with the number of replications and the standard error of the individual tests. With this information, the dependence of NOx emissions on biodiesel blending percent can be determined as accurately as if the individual test values had been reported and the appropriate statistical tests for the significance of results can be performed.

Regression analysis is used as the primary method of analysis. For each engine and test cycle, the emission averages for each fuel are regressed against the biodiesel blending percent to determine a straight line. The regression weights each data point in inverse proportion to the square of its standard error to account for differences in the number and reliability of emission measurements that make up each average. The resulting regression line will pass through the mean value estimated from the data (i.e., the average NOx emission level at the average blending percent), while the emission averages for each fuel may scatter above and below the regression line due to uncertainties in their measurement. The slope of the line estimates the dependence of NOx emissions on the blending percentage.

Where the data points closely follow a straight line and the slope is determined to be statistically significant, one can conclude that blending biodiesel with a base fuel will increase NOx emissions in proportion to the blending percent. The regression line can then be used to estimate the predicted emissions increase for a given blending percent. The predicted emissions increase is the value one would expect on average over many measurements and is comparable to the average emissions increase one would expect in a fleet of vehicles.

The same level of analysis is not possible for the testing on B5 fuel, which is reported as a simple average for the on-road engines and is not reported at all for the off-road engines. For the B5 fuel, Durbin 2011 presents emission test results in a tabulated form where the percentage change in NOx emissions has been computed compared to ULSD base fuel. This form supports the presentation of results graphically, but it does not permit a proper statistical analysis to be performed. Specifically, the computation of percentage emission changes will perturb the error distribution of the data, by mixing the uncertainty in measured emissions on the base fuel with the uncertainties in measured emissions on each biodiesel blend, and it can introduce bias as a result of the mixing. Further statistical analysis of the computed percent values should be avoided because of these problems. Therefore, a more limited trend analysis of the NOx emissions data for B5 and the John Deere engine is conducted.

3.3 2006 Cummins Engine (Engine Dynamometer Testing)

Table 3-3 shows the NOx emission results for the 2006 model-year Cummins heavy-duty diesel engine based on a re-analysis of the data for this report. As indicated by highlighting in the table, the relationship between increasing biodiesel content and increased NOx emissions for soy-based biodiesel is statistically significant at >95% confidence level[17] in all cases. For the animal-based biodiesel, the relationship is statistically significant at the 92% confidence level for the UDDS cycle, the 94% confidence level for the 50 mph cruise, and the >99% confidence level for the FTP cycle.

For the soy-based fuels, the R^2 statistics show that the emissions effect of biodiesel is almost perfectly linear with increasing biodiesel content over the range B20, B50, and B100. Although not as high for the animal-based fuels (because the emissions effect is smaller and measurement errors are relatively larger in comparison to the trend), the R^2 statistics nevertheless establish a linear increase in NOx emissions with increasing biodiesel content over the same range. The linearity of the response with blending percent is well supported by the many NOx emissions graphs contained in Durbin 2011.

The table also gives the estimated NOx emission increases for B5 and B10 as predicted by the regression lines. For soy-based fuels, the values are 1% for B5 (range 0.8% to 1.3% depending on the cycle) and 2% for B10 (range 1.6% to 2.6% depending on cycle).

[17] A result is said to be statistically significant at the 95% confidence level when the p value is reported as $p \leq 0.05$. At the $p \leq 0.01$ level, a result is said to be statistically significant at the 99% confidence level, and so forth.

Table 3-3 Re-Analysis for 2006 Cummins Engine (Engine Dynamometer Testing) Model: NOx = A + B · BioPct Using ULSD, B20, B50, and B100 fuels							
Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	Pct Change	Pct Change
Soy-based							
	UDDS	0.997	5.896	0.0100 [a]	0.001	0.8%	1.7%
	FTP	0.995	2.024	0.0052	0.003	1.3%	2.6%
	40 mph	1.000	2.030	0.0037	<0.0001	0.9%	1.8%
	50 mph	0.969	1.733	0.0028	0.016	0.8%	1.6%
Animal-based							
	UDDS	0.847	5.911	0.0021 [b]	0.080	0.2%	0.4%
	FTP	0.981	2.067	0.0031	0.001	0.7%	1.4%
	50 mph	0.887	1.768	0.0011	0.058	0.3%	0.6%

Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better.
[b] Orange highlight indicates result is statistically significant at the 90% confidence level or better.

For animal-based fuels, the values are approximately one-half as large: 0.4% for B5 (range 0.2% to 0.7%) and 0.8% for B10 (range 0.4% to 1.4%). These predicted increases are statistically significant to the same degree as the slope of the regression line from which they are estimated. That is, the NOx increases predicted by the regression line for soy-based fuels are statistically significant at the 95% confidence level (or better) on all cycles and the predicted NOx increases for animal-based fuels are statistically significant at the 90% confidence level (or better) on all cycles and at the >99% confidence level for the FTP.

Because the limited data on B5 were not used to develop the regression lines for each cycle, and no test data on B10 are available, use of the lines to make predictions for B5 and B10 depends on their linearity over the range between ULSD and B20. Based on the R^2 statistics and the graphs in Durbin 2011, the slopes observed between ULSD and B20 are the same as the slopes observed between B20 and B100 for each of the test cycles. We believe that the linearity of the response with blending percent for values over the range ULSD to B100 would be accepted by the large majority of researchers in the field, as would the use of regression analysis to make predictions for B5 and B10.

ADF B3-73

The Durbin 2011 report takes a different approach for determining the statistical significance of NOx emission increases for each fuel. For each fuel tested, it computes a percentage change in emissions for NOx (and other pollutants) relative to the ULSD base fuel. It then determines the statistical significance of each observed change using a conventional t-test for the difference of two mean values (2-tailed, 2 sample equal

variance t-test). The t-test is conducted on the measured emission values before the percentage emission change is computed.

The t-test would be the appropriate approach for determining statistical significance if only two fuels were tested. However, it is a simplistic approach when three or more fuels are tested because it is applied on a pair-wise basis (B5 vs. ULSD, B20 vs. ULSD, etc.) and does not make use of all of the data that is available. It will have less power than the regression approach to detect emission changes that are real. This limitation is in one direction, however, in that the test is too weak when 3 or more data points are available, but a finding of statistical significance is valid when it occurs. As long as the linear hypothesis is valid, the regression approach should be the preferred method for analysis and for the determination of whether biodiesel blending significantly increases NOx emissions.

ADF B3-74

Because emission changes will be smallest for B5 (because of the low blending volume), the pair-wise t-test is most likely to fail to find statistical significance at the B5 level. In cases where the pair-wise t-test for B5 says that the emission change vs. ULSD is not statistically significant – but slope of the regression line is statistically significant – the proper conclusion is that additional B5 testing (to improve the precision of the emission averages) would likely lead to the detection of a statistically significant B5 emissions change using the t-test. In this case, the failure to find statistical significance using the t-test is not evidence that B5 does not increase NOx emissions.

For this engine, soy-based B5 was tested on the 40 mph and 50 mph cruise cycles and animal-based B5 was tested on the FTP. To examine this matter further, Table 3-4 reproduces NOx emission results reported in Tables ES-2 and ES-3 of Durbin 2011. Soy-based B5 was shown to increase NOx emissions on the 40 mph cruise cycle, but not on the 50 mph cruise cycle. Animal-based B5 was shown to increase NOx emissions on the FTP. Durbin 2011 noted (p. xxxii) that "[t]he 50 mph cruise results were obscured, however, by changes in the engine operation and control strategy that occurred over a segment of this cycle." Therefore, we discount the 50 mph cruise results and do not consider them further. Neither of the remaining B5 NOx emission increases (for the 40 mph Cruise and FTP cycles) were found to be statistically significant using the t-test, although the 40 mph cruise result for soy-based fuels comes close to being marginally significant (it would be statistically significant at an 86.5% level). The NOx emission increases at higher blending levels were found have high statistical significance (>99% confidence level).

ADF B3-75

This format, used throughout Durbin 2011 to report emission test data and to show the effect of biodiesel on emissions, is subject to an important statistical caveat. The percent changes are computed by dividing the biodiesel emission values by the emissions measured for the ULSD base fuel. Therefore, measurement errors in the ULSD measurement are blended with the measurement errors for each of the biodiesel fuels. The blending of errors in each computed percent change can bias the apparent trend of emissions with increasing biodiesel content. As will be shown in Section 3.3.2, we can see this problem in the animal-based B5 test data for this engine.

Table 3-4 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 2006 Cummins Engine (Engine Dynamometer Testing)						
	Soy-based Biodiesel				Animal-based Biodiesel	
	40 mph Cruise		50 mph Cruise		FTP	
	NOx % Diff	p value	NOx % Diff	p value	NOx % Diff	p value
B5	1.7%	0.135	-1.1%	0.588	0.3%	0.298
B20	3.9%[a]	0.000	0.5%	0.800	1.5%	0.000
B50	9.1%	0.000	6.3%	0.001	6.4%	0.000
B100	20.9%	0.000	18.3%	0.000	14.1%	0.000

Source: Table ES-2 and ES-3 of Durbin 2011, p. xxviii
Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on the pair-wise t-test.

3.3.1 NOx Impact of Soy-based Biodiesel at the B5 Level

Figures 3-1a and 3-1b display the trend of NOx emissions with blending percent for the soy-based biodiesel on the 40 mph cruise cycle. Figure 3-1a plots the percentage increases as reported by Durbin 2011 in contrast to two different analytical models for the relationship:

- The Linear Model shown by the blue line; and
- The Staff Threshold model (black line), in which the NOx emission change is zero through B9 and then increases abruptly to join the linear model.

In Figure 3-1a, the linear model is an Excel trendline for the computed percent changes. While the data violate a key assumption for the proper use of regression analysis, this approach is the only way to establish a trendline given the form in which Durbin 2011 tabulates the data and presents the results of its testing.

Figure 3-1b plots the actual measured emission values in g/bhp-hr terms in contrast to the same two analytical models. Here, the linear model line is determined through a proper use of regression analysis, in which each emission average in g/bhp-hr terms is weighted inversely by the square of its standard error, using the data for ULSD, B20, B50 and B100 (i.e., excluding the B5 data point). In the case of this engine and biodiesel fuel, both forms of assessment show generally the same trend for NOx emissions as a function of blending percent. Although the NOx emission increases for B5 may fail the t-test for significance, emissions are increased at B5 and the B5 data point is fully consistent with the Linear Model. The Threshold model is clearly a less-satisfactory representation of the test data.

ADF B3-76

Figure 3-1a
Durbin 2011 Assessment: 40 mph Cruise Cycle NOx Emissions Increases for Soy-Biodiesel Blends (2006 Cummins Engine)

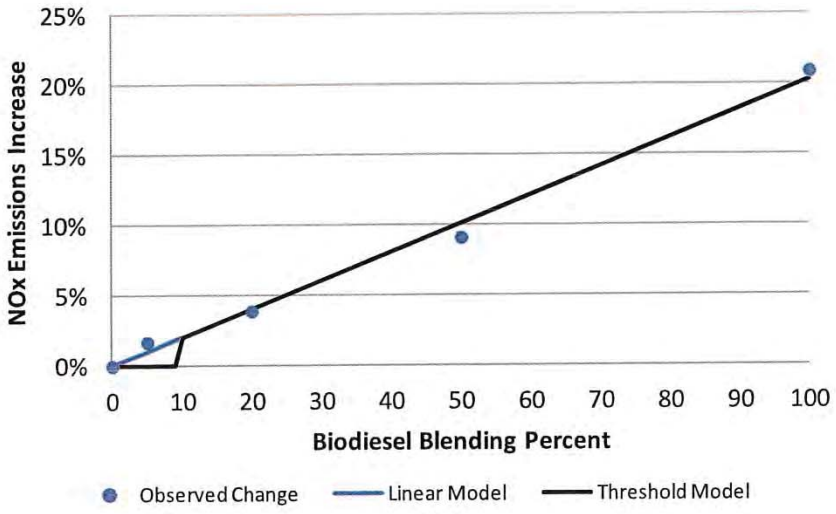
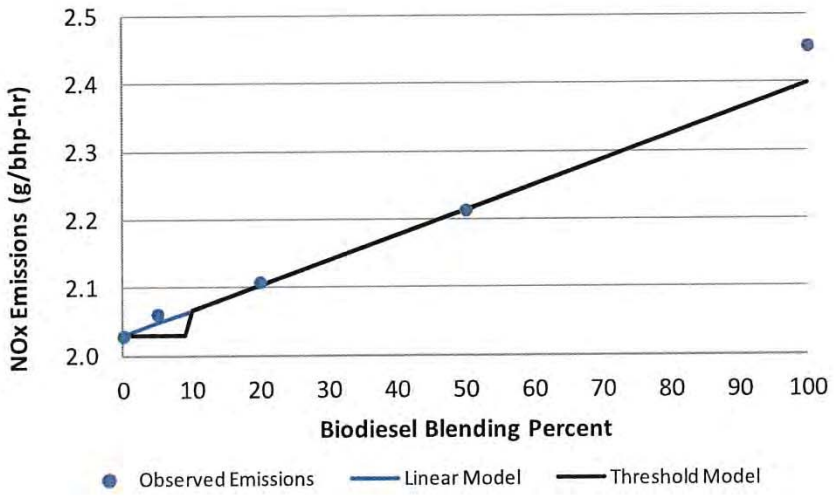


Figure 3-1b
Re-assessment of 40 mph Cruise Cycle NOx Emissions Increases for Soy-Biodiesel Blends (2006 Cummins Engine)



Note that the slope of the trendline (Figure 3-1a) is greater than the slope of the regression line (Figure 3-1b). In the latter figure, the B100 data point stands above the regression line, which passes below it. The regression line (but not the trendline) is fit in

a manner that accounts for the uncertainties in each data point, so that the line will pass closer to points that have smaller uncertainties and farther from points that have greater uncertainties. For these data, the B100 data point has the largest uncertainty (±0.026 g/bhp-hr) followed by the B20 data point (±0.025 g/bhp-hr). The other three data points (ULSD, B5, and B50) have uncertainties less than ±0.001 g/bhp-hr. The B20 data point happens to fall on the line, but the B100 data point is found to diverge above. Because the regression analysis can account for the relative uncertainties of the data points, it provides a more accurate and reliable assessment of the impact on NOx emissions.

ADF B3-77

3.3.2 NOx Impact of Animal-based Biodiesel at the B5 level

Figures 3-2a and 3-2b display the trend of NOx emissions with blending percent for the animal-based biodiesel on the FTP test cycle as reported by Durbin 2011 and as re-assessed in this report using regression analysis, respectively. As Figure 3-2a shows, the NOx percent change values reported by Durbin 2011 appear to follow the Staff Threshold model in that NOx emissions are not materially increased at B5, but are increased significantly at B20 and above. As a result, the blue trendline in the figure (fit from the B20, B50 and B100 data points) has a negative intercept.

Figure 3-2b paints a very different picture from the data. Here, the ULSD and B5 data points stand above the weighted regression line (blue) developed from the data for ULSD, B20, B50 and B100. In the data used to fit the regression line, the ULSD data point has the largest uncertainty (±0.013 g/bhp-hr) while the other three data points (B20, B50, and B100) have uncertainties of ±0.002 g/bhp-hr (one case) and ±0.001 g/bhp-hr (two cases). Considering all of the data, the B5 data point has the second highest uncertainty (±0.007 g/bhp-hr). The regression line closely follows a linear model with a high R^2 (0.981) considering the weighted errors, while the ULSD and B5 points lie above it.

ADF B3-78

Because the ULSD data point is subject to more uncertainty and appears to be biased high compared to the regression line, the NOx percent changes computed by Durbin 2011 are themselves biased. The trendline result in Figure 3-2a that appeared to be supportive of the Staff Threshold model now appears to be the result of biases in the ULSD and B5 emission averages.

Two important conclusions can be drawn from the foregoing:

1. Accurate and reliable conclusions regarding the impact of B5 on NOx emissions cannot be drawn from the computed percent changes that are reported in Durbin 2011. Nor can accurate and reliable conclusions be drawn from visual inspection of graphs that present such data. Weighted regression analysis of the measured emission values (g/bhp-hr terms) must be performed so that the uncertainties in emissions measurements can be fully accounted for.

ADF B3-79

2. When a weighted regression analysis is performed using the testing for this engine, there is no evidence that supports the conclusion that B5 blends will not increase NOx emissions. In fact, the data are consistent with the conclusion that biodiesel increases NOx emissions in proportion to the blending percent.

ADF B3-80

Figure 3-2a
Durbin 2011 Assessment: FTP NOx Emissions Increases for Animal-based Biodiesel Blends (2006 Cummins Engine)

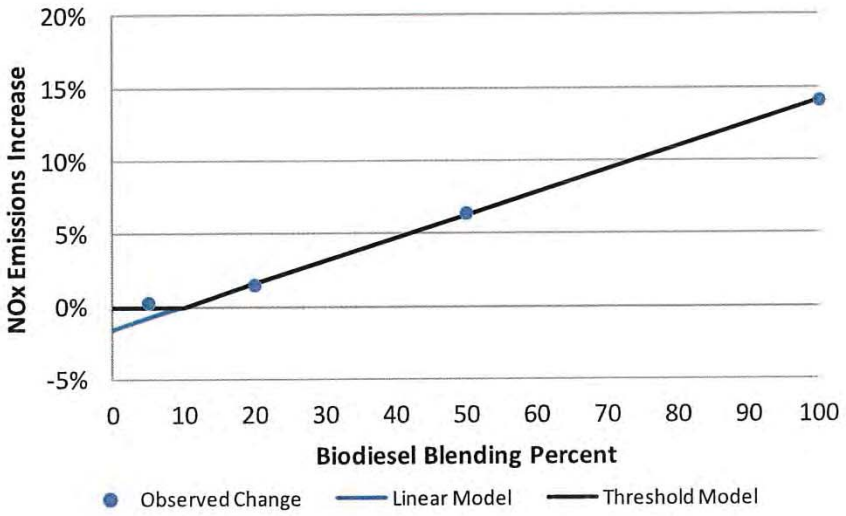
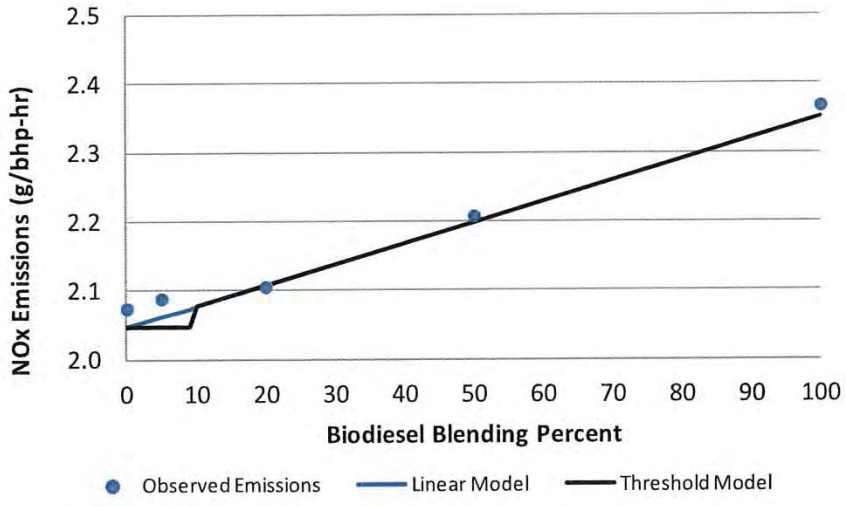


Figure 3-2b
Re-assessment of FTP NOx Emissions Increases for Animal-based Biodiesel Blends (2006 Cummins Engine)



3.4 2007 MBE4000 Engine (Engine Dynamometer Testing)

To analyze the data for the 2007 MBE4000 engine, it has proved necessary to remove two data points, one for the soy-based B20 fuel on the 50 mpg cruise cycle and one for the animal-based B50 fuel on the FTP test cycle:

- Appendix H reports the 50 mph cruise emission average for soy-based B20 to be 0.014 ± 0.020 g/bhp-hr. This value is implausible and wholly inconsistent with the NOx emission change of +6.9% reported in Table ES-4 of Durbin 2011, which would imply a NOx emission average of 1.21*1.069 = 1.30 g/bhp-hr.

- Appendix H reports the FTP emission average for the animal-based B50 fuel to be 2.592 ± 0.028 g/bhp-hr, which stands well above the other test data on animal-based biodiesel. This value is also inconsistent with the NOx emission change of +12.1% reported in Table ES-4 of Durbin 2011, which would imply a NOx emission average of 1.29*1.121 = 1.45 g/bhp-hr.

We believe these reported values are affected by typographical errors and have deleted them from the dataset used here.

With these corrections, Table 3-5 shows the results of the NOx emissions analysis for the 2007 model-year MBE4000 heavy-duty diesel engine. As indicated by highlighting in the table, the relationship between increasing biodiesel content and increased NOx emissions is statistically significant at >99% confidence level in two cases for soy-based biodiesel (the UDDS and FTP cycles) and at the 90% confidence level in one case (the 50 mph cycle). For the animal-based biodiesel, the relationship is statistically significant at the 96% confidence level for the UDDS cycle, the 98% confidence level for the FTP cycle, and >99% confidence level for the 50 mph cycle.

ADF B3-81

Durbin 2011 again notes a problem with the 50 mph cruise test results, saying (p. xxxii) that "[the NOx] trend was obscured, however, by the differences in engine operation that were observed for the 50 mph cruise cycle." Therefore, we will focus the discussion on the UDDS and FTP results.

For the soy-based fuels, the R^2 statistics show that the emissions effect of biodiesel is almost perfectly linear with increasing biodiesel content over the range from ULSD to B20, B50, and B100 for all cycles (including the 50 mph cruise). That is, the NOx emissions increase between ULSD and B20 shares the same slope as the NOx emissions increase between B20 and B100. For the animal-based biodiesel, the R^2 statistics also establish a linear increase in NOx emissions with increasing biodiesel content over the same range. The linearity of the response with blending percent is also well supported by the many NOx emissions graphs contained in Durbin 2011.

Tab le 3-5 Re-Analysis for 2007 MBE4000 En gine (En gine Dynam ometer Testing) Model: NOx = A + B · BioPct Using ULSD, B20, B50, and B100 fuels							
Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	Pct Change	Pct Change
Soy-based							
	UDDS	0.989	2.319	0.0090 [a]	0.005	4.6%	9.1%
	FTP	0.998	1.268	0.0049	0.006	2.5%	5.0%
	50 mph	0.979	1.198	0.0054 [b]	0.092	2.7%	5.5%
Animal-based							
	UDDS	0.913	2.441	0.0036	0.044	2.0%	4.0%
	FTP	0.999	1.288	0.0038	0.020	2.5%	5.0%
	50 mph	0.994	1.205	0.0049	0.003	2.5%	5.0%

Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better.
[b] Orange highlight indicates result is statistically significant at the 90% confidence level or better.

The table also gives the estimated NOx emission increases for B5 and B10 as predicted by the regression lines. For soy-based fuels, the values are ~3.5% for B5 (range 2.5% to 4.6% depending on the cycle) and ~7.5% for B10 (range 5.0% to 9.1% depending on cycle). For animal-based fuels, the values are approximately two-thirds as large: ~2.3% for B5 (range 2.0% to 2.5%) and ~4.5% for B10 (range 4.0% to 5.0%). The predicted increases are statistically significant to the same degree as the slope of the regression line from which they are estimated. That is, the predicted NOx increases are statistically significant at the >99% confidence level for soy-based fuels on the UDDS and FTP cycles and at the >95% confidence level for animal-based fuels on all cycles. The predicted NOx increase is statistically significant at the 90% confidence level for soy-based fuels on the 50 mph cruise cycle.

ADF B3-82

For this engine, soy- and animal-based B5 were tested on the FTP. Table 3-6 reproduces the NOx emission results reported in Tables ES-4 and ES-5 of Durbin 2011. While there are caveats on use of the pair-wise t-test, the FTP test data for this engine show NOx emissions at the B5 level for both soy- and animal-based fuels that are statistically significant at the 99% confidence level (or better) in this case. That is, the test data for this engine as reported by Durbin 2011 refute the Staff Threshold Model that biodiesel blends below B10 do not increase NOx emissions.

Table 3-6 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 2007 MBE4000 Engine (Engine Dynamometer Testing)				
	Soy-Based Biodiesel FTP		Animal-Based Biodiesel FTP	
	NOx % Diff	p value	NOx % Diff	p value
B5	0.9% [a]	0.007	1.3%	0.000
B20	5.9%	0.000	5%	0.000
B50	15.3%	0.000	12.1	0.000
B100	38.1%	0.000	29%	0.000

Source: Table ES-4/5 of Durbin 2011, p. xxix
Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on pair-wise t-test.

Figures 3-3a and 3-3b below compare the FTP data for this engine to the regression line representing the linear model (blue) and the Staff Threshold model (black) for both soy- and animal-based biodiesel. In both cases, the regression line was developed using the data for ULSD, B20, B50, and B100 (i.e., excluding the B5 data point). For both soy- and animal-based biodiesels, the data point for B5 falls on the established line, while the Staff Threshold model is inconsistent with the data. For this engine, it is clear that soy- and animal-based biodiesels increase NOx emissions at all blending levels.

ADF B3-83

Figure 3-3a
Re-assessment of FTP Cycle NOx Emissions Increases for Soy-based Biodiesel Blends (2007 MBE4000 Engine)

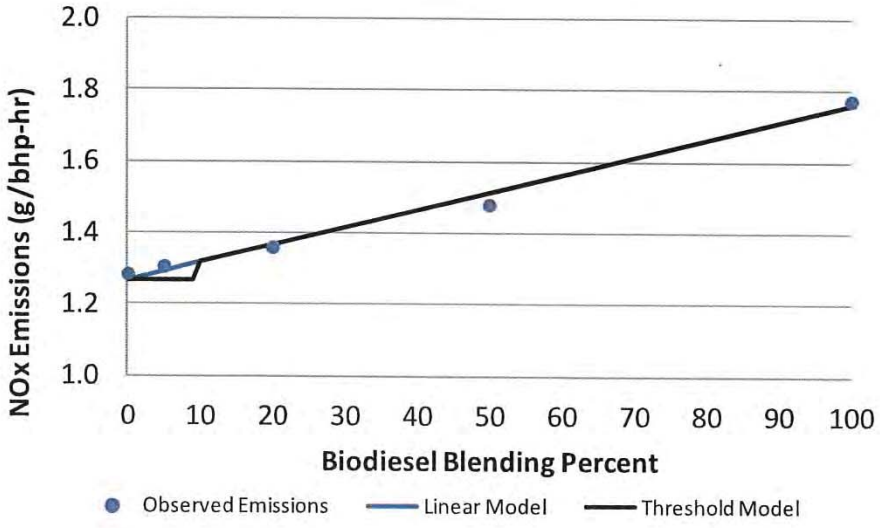
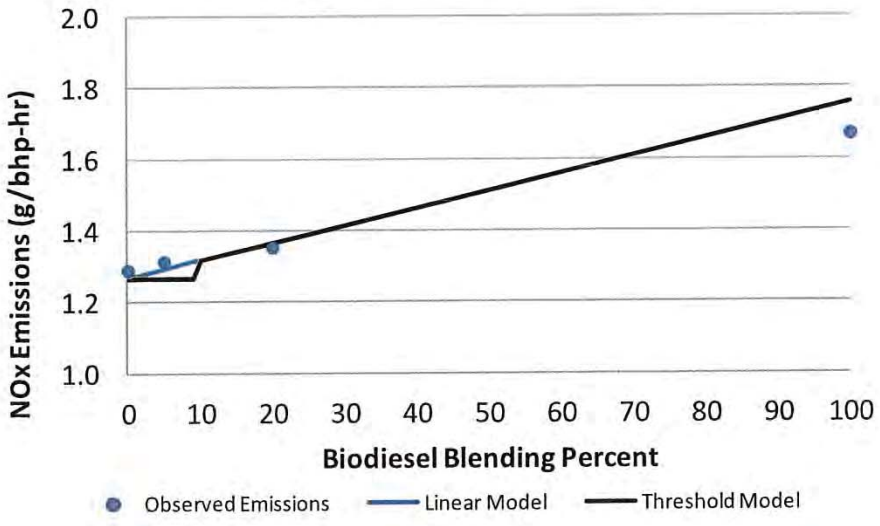


Figure 3-3b
Re-assessment of FTP Cycle NOx Emissions Increases for Animal-based Biodiesel Blends (2007 MBE4000 Engine)



3.5 1998 Kubota TRU Engine (Engine Dynamometer Testing)

The 1998 Kubota V2203-DIB off-road engine was tested on the base fuel (ULSD) and soy-based biodiesel at four blending levels (B5, B20, B50, B100) in two different series using the ISO 8178 (8-mode) test cycle. Appendix I reports the measured emissions data only for the first series (ULSD, B50, B100). Using this subset of data, Table 3-7 summarizes the results of the re-analysis for this engine.

As for the other engines, the results of the analysis demonstrate the following:

- The high R^2 statistic shows that the emissions effect of biodiesel is almost perfectly linear over the range B50 and B100. That is, the slope from ULSD to B50 is the same as the slope from B50 to B100. The slope of the regression line is statistically significant at the 99% confidence level.

- NOx emissions are estimated to increase by 1.0% at the B5 level and by 2.1% at the B10 level. These estimated NOx emission increases are statistically significant to the same high degree as the regression slope on which they are based.

ADF B3-84

Table 3-7 Re-Analysis for 1998 Kubota V2203-DIB Engine (Engine Dynamometer Testing) Model: NOx = A + B · BioPct Using ULSD, B50, and B100 fuels							
Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	Pct Change	Pct Change
Soy-based	ISO 8178	0.999	12.19	0.0256 [a]	0.01	1.0%	2.1%

Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better.

The second test series involved ULSD, B5, B20, and B100 fuels. Measured emissions data are not given in Appendix I, so we must work with the calculated percent changes in NOx emissions tabulated in Durbin 2011. Table 3-8 reproduces the NOx emission results reported in Table ES-8 of Durbin 2011 for the two test series. For the second test series, biodiesel at the B5 level increased NOx emissions, but the result fails the pair-wise t-test for statistical significance. The NOx emission increase at the B20 level was statistically significant at the 90% confidence level, and the increase at the B100 level was statistically significant at the >99% confidence level. The significance determinations use the pair-wise t-test, which is subject to caveats, but this is the only method available to gauge significance because re-analysis of the computed percentage changes is not possible.

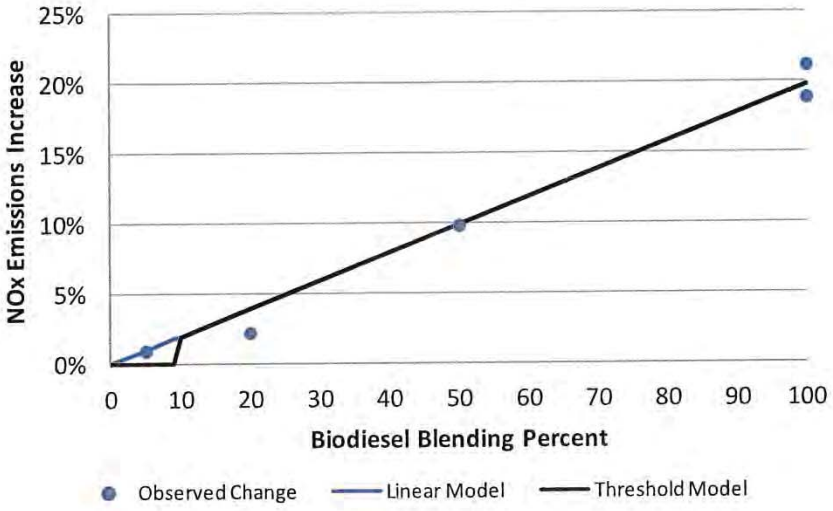
ADF B3-85

Table 3-8 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 1998 Kubota TRU Engine (Engine Dynamometer Testing)				
	Soy-Based Biodiesel Series 1 ISO 8178		Soy-Based Biodiesel Series 2 ISO 8178	
	NOx % Diff	p value	NOx % Diff	p value
B5	Not tested		0.97%	0.412
B20	Not tested		2.25% [a]	0.086
B50	7.63% [b]	0.000	Not tested	
B100	13.76%	0.000	18.89%	0.000

Source: Table ES-8 of Durbin 2011, p. xxxviii
Notes:
[a] Orange highlight indicates result is statistically significant at the 90% confidence level or better based on pair-wise t-test.
[b] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on pair-wise t-test

Figure 3-4 displays the trend of NOx emissions with blending percent for the first and second test series combined. As the figure shows, the available data points scatter around the trendline determined from the emission change percentages (not from regression analysis). The B20 data point falls below the trend line while the two B100 data points bracket the trend line. It is not possible to explain the divergence of the B20 data point

Figure 3-4
Durbin 2011 Assessment: ISO 8178 Cycle NOx Emissions Increases for Soy-based Biodiesel Blends (1998 Kubota Engine, Test Series 1 and 2 Combined)



ADF B3-86

because the emissions data for the second test series are not published in Durbin 2011. The B5 data point clearly supports the Linear Model and is inconsistent with the Staff Threshold Model.

3.6 2009 John Deere Off-Road Engine (Engine Dynamometer Testing)

ADF B3-87

The only information on the 2009 John Deere off-road engine comes from the tabulation of calculated percentage emission changes. Table 3-9 reproduces these data from Table ES-7 of Durbin 2011. For the soy-based biodiesel, NOx emissions are significantly increased at the B20 and higher blend levels. The increase for B20 is statistically significant at the 90% confidence level and the increases for B50 and B100 are statistically significant at the >99% confidence level based on the pair-wise t-test. A soy-based B5 fuel was not tested.

Table 3-9 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 2009 John Deere Engine (Engine Dynamometer Testing)				
	Soy-Based Biodiesel ISO 8178		Animal-Based Biodiesel ISO 8178	
	NOx % Diff	p value	NOx % Diff	p value
B5	Not tested		-3.82	0.318
B20	2.82%[a]	0.021	-2.20	0.528
B50	7.63%	0.000	Not tested	
B100	13.76%	0.000	4.57	0.000

Source: Table ES-7 of Durbin 2011, p. xxxviii
Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on pair-wise t-test.

For animal-based biodiesel, the testing shows the unusual result that B5 and B20 appear to decrease NOx emissions, while B100 increases NOx. The B5 and B20 decreases are not statistically significant, while the B100 increase is statistically significant at the >99% confidence level. Durbin 2011 concludes:

> The animal-based biodiesel also did not show as great a tendency to increase NOx emissions compared to the soy-based biodiesel for the John Deere engine, with only the B100 animal-based biodiesel showing statistically significant increases in NOx emissions.[18]

Durbin 2011 does not discuss these results further and does not note any problems in the testing, making further interpretation of the results difficult. Figure 8-1 of Durbin 2011 presents the NOx results for this engine with error bars. First, we note that the figure appears to suggest that NOx emissions were increased on the B20 fuel in contradiction to the table above. Second, it is clear that the error bars are large enough that no difference in NOx emissions can be detected among ULSD, B5, and B20 fuels. Overall, this result could be consistent with the Staff Threshold Model through B5, but the failure to detect a NOx emission increase at B20 is not. Without further information, it is not possible to determine whether the result seen here is a unique response of the John Deere engine to animal-based biodiesel or is the result of a statistical fluctuation or an artifact in the emissions data.

ADF B3-87 cont.

3.7 Conclusions

The Biodiesel Characterization report prepared by Durbin et al. for CARB is an important source of information on the NOx emissions impact of biodiesel fuels in heavy-duty engines. It is the sole source of information on the NOx impact of B5 blends cited in the ISOR. When the engine dynamometer test data are examined for

ADF B3-88 cont.

[18] Durbin 2011, p. xx.

the three engines for which emissions test data have been published, we find clear evidence that biodiesel increases NOx emissions in proportion to the blending percent. Where B5 fuels were tested for these engines, NOx emissions are found to increase above ULSD for both soy- and animal-based blends in all three engines and by statistically significant amounts in one engine.

ADF B3-88 cont.

Specifically, a re-analysis of the NOx emissions test data demonstrates the following:

1. For the 2006 Cummins engine, biodiesel fuels are found to significantly increase NOx emissions for both soy- and animal-based blends by amounts that are proportional to the blending percent. This result indicates that biodiesels will increase NOx emissions at blending levels below B10. When B5 fuels were tested, NOx emissions were observed to increase but by amounts that fail to reach statistical significance according to the pair-wise test.[19] Graphical analysis demonstrates that NOx emissions measured for B5 fuels are consistent with the Linear Model, but not the Staff Threshold Model.

ADF B3-89

2. For the 2007 MBD4000 engine, biodiesel fuels are found to significantly increase NOx emissions for both soy- and animal-based blends by amounts that are proportional to the blending percent. This result indicates that biodiesels will increase NOx emissions at blending levels below B10. When B5 fuels were tested, NOx emissions were observed to increase and by amounts that are found to be statistically significant using the pair-wise t-test.[13] This result alone is sufficient to disprove the Staff Threshold Model. Graphical analysis demonstrates that NOx emissions measured for B5 fuels are consistent with the Linear Model, but not the Staff Threshold Model.

ADF B3-90

3. For the 1998 Kubota TRU (off-road) engine, soy-based biodiesel fuels are found to significantly increase NOx missions. Animal-based biodiesel was not tested. When a soy-based B5 fuel was tested, NOx emissions were observed to increase but by amounts that fail to reach statistical significance according to the pair-wise test.[13] Graphical analysis demonstrates that NOx emissions measured for B5 fuels are consistent with the Linear Model, but not the Staff Threshold Model.

ADF B3-91

The measured emissions test data for the other off-road engine (2009 John Deere) are not contained in the Durbin 2011 report and CARB has not made them publicly available. Thus, a re-analysis was not possible. Based on the tables and figures in Durbin 2011, soy-based biodiesel fuels were shown to significantly increase NOx emissions at B20 levels and higher, but B5 was not tested. Testing of animal-based blends shows no change in NOx emissions at B5 and B20 levels, but B100 is shown to significantly increase NOx emissions. Durbin 2011 discusses this result only briefly, and it is unclear what conclusions can be drawn from it.

ADF B3-92

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[19] As discussed in Section 3.3, the pair-wise t-test is not the preferred method for demonstrating statistical significance.

3_B_ADF_GE Responses (Page 167 – 204)

170. Comment: **ADF B3-47 through ADF B3-56, ADF B3-64 through ADF B3-68, ADF B3-72, ADF B3-74, ADF B3-76 through ADF B3-80, and ADF B3-88**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

171. Comment: **ADF B3-57**
The comment states that ARB staff did not make all of the Durbin 2011 data available to the public.

Agency Response:
Please see response **ADF B3-20**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations." For more information on the completeness of the rulemaking file, including data, public workshop presentations, and written feedback and comments, please see response **ADF 5-3**.

172. Comment: **ADF B3-58**
The comment requests that all of the Durbin 2011 data should be made publicly available.

Agency Response:
Please see response **ADF B3-20**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations." For more information on the completeness of the rulemaking file, including data, public workshop presentations, and written feedback and comments, please see response **ADF 5-3**.

173. Comment: **ADF B3-59**
The comment summarizes some of the 2013 ARB Emission Testing test results and compares them to the earlier results in the Durbin 2011 study.

Agency Response:
The comment does not constitute an objection or recommendation regarding the 2015 ADF regulation.

174. Comment: **ADF B3-60**
The comment summarizes some of the 2013 ARB Emission Testing test results and compares them to the earlier results in the Durbin 2011 study.

Agency Response:
The comment does not constitute an objection or recommendation regarding 2015 ADF regulation.

175. Comment: **ADF B3-61**
The comment questions whether the animal based biodiesel blendstock in the fuel studies ARB staff used, was representative of animal-based biodiesels in general.

Agency Response:
The properties of the animal based biodiesel used in the mentioned study were measured and met all of the applicable standards for biodiesel blendstocks. As with any fuel there are differences in properties from batch to batch, and this batch of biodiesel derived from animal feedstocks had slightly different properties than the animal derived biodiesel in other tests. ARB staff does not believe this significantly affected the validity of the results of the testing.

176. Comment: **ADF B3-62**
The comment states that using a blend threshold will result in increases in NOx emissions.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed (unrestricted use of B5 and B10) are no longer present in the 2015 ADF regulation. In the current regulation, biodiesel emissions are mitigated either by offsetting factors or by in-use requirements.

177. Comment: **ADF B3-63**
The comment states that available data does not support the threshold model developed by ARB staff.

Agency Response:
The comment is related to the 2013 ADF proposal. The threshold model and analysis discussed is no longer present in the 2015 ADF Staff Report and 2015 ADF regulation.

178. Comment: **ADF B3-69**
The comment states that the studies evaluated by ARB staff do not provide evidence for the outcome of NOx emissions below B10.

Agency Response:
The comment is related to the 2013 ADF proposal. Results from an ARB commissioned study provided additional information on B5.

179. Comment: **ADF B3-70**
The comment states the studies evaluated by ARB staff cannot validate their threshold model.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed are no longer in the 2015 ADF regulation.

180. Comment: **ADF B3-71**
The comment states that the literature review conducted by ARB staff includes studies that present evidence that NOx impacts from biodiesel is present at very low blend levels.

Agency Response:
The comment does not constitute an objection or recommendation regarding the 2015 ADF regulation. That said, staff incorporated the data from the studies in the literature review into the statistical analysis.

181. Comment: **ADF B3-73**
The commenter proposes to speak for "a large majority of researchers in the field" by advising that a linear response to blending percent would be acceptable.

Agency Response: The comment does not constitute an objection or recommendation regarding the 2015 ADF regulation. That said, staff has carefully analyzed available data on this issue and stands by the analysis and explanations contained in the Staff Report and other rulemaking documents.

182. Comment: **ADF B3-75**
The comment alleges that the Durbin 2011 emission results are biased.

Agency Response:
Selectively excluding data from the analysis, or, equivalently, giving different data sets more or less weight according to their perceived reliability, can be a useful analytical tool. However, great care must be

exercised in order to avoid skewing the results towards a preferred conclusion.

ARB staff took pains to avoid compromising the objectivity of the analysis as a result of emphasizing some data sets over others. Prior to conducting the analysis, a decision was made to only use data from engine tests, not whole vehicle tests. This was done because testing vehicles introduces a large amount of variability into the results, which tends to obscure the effects under study. This decision was made prior to the analysis and did not affect the objectivity of the conclusions.

As a sensitivity check, ARB staff performed their analysis with certain data sets excluded. As expected, that did change the results to some degree. However, staff deemed that the need for an impartial assessment of all the available data outweighed any potential advantages of excluding or selectively emphasizing some of the data.

The secondary comment regarding the way the test data are presented in Durbin 2011 is no longer relevant since ARB re-analyzed the original data.

183. Comment: **ADF B3-81**
The comment summarizes details from the Durbin 2011 study findings.

Agency Response:
The comment does not constitute an objection or recommendation regarding the 2015 ADF regulation.

184. Comment: **ADF B3-82**
The comment states that the test data from Durbin 2011 contradicts the threshold model developed by ARB staff.

Agency Response:
The comment relates to the 2013 ADF proposal. The provisions discussed (a B10 threshold) are no longer in the 2015 ADF regulation.

185. Comment: **ADF B3-83**
The comment states that the Durbin 2011 data does not support the threshold model developed by ARB staff.

Agency Response:
The comment relates to the 2013 ADF proposal. The provisions discussed (a B10 threshold) are no longer in the 2015 ADF regulation.

186. Comment: **ADF B3-84**
The comment summarizes details from the Durbin 2011 study.

Agency Response:
The comment does not constitute an objection or recommendation regarding the proposal released in December 2014.

187. Comment**: ADF B3-85**
The comment summarizes details from the Durbin 2011 study.

Agency Response:
The comment does not constitute an objection or recommendation regarding the proposal released in December 2014.

188. Comment**: ADF B3-86**
The comment states that the Durbin 2011 results do not lend support to the threshold model developed by ARB staff.

Agency Response:
The comment relates to the 2013 ADF proposal. The provisions discussed (a B10 threshold) are no longer in the 2015 ADF regulation.

189. Comment: **ADF B3-87**
The comment summarizes details from the Durbin 2011 study findings.

Agency Response:
The comment does not constitute an objection or recommendation regarding the 2015 ADF regulation.

190. Comment: **ADF B3-89**
The comment states that the Durbin 2011 results do not lend support to the threshold model developed by ARB staff.

Agency Response:
The comment relates to the 2013 ADF proposal. The provisions discussed (a B10 threshold) are no longer in the 2015 ADF regulation.

191. Comment: **ADF B3-90**
The comment states that the Durbin 2011 results do not lend support to the threshold model developed by ARB staff.

Agency Response:
The comment relates to the 2013 ADF proposal. The provisions discussed (a B10 threshold) are no longer in the 2015 ADF regulation.

192. Comment: **ADF B3-91**
The comment states that the Durbin 2011 results do not lend support to the threshold model developed by ARB staff.

Agency Response:
The comment relates to the 2013 ADF proposal. The provisions discussed (a B10 threshold) are no longer in the 2015 ADF regulation

193. Comment: **ADF B3-92**
The comment contends that not all of the emissions test data was made publicly available in the rulemaking file.

Agency Response:
For information on ARB's rulemaking documentation, please see responses **ADF 5-3** and **ADF 17-11**.

APPENDIX A

RESUME OF ROBERT W. CRAWFORD

Education

1978 Doctoral Candidate, ScM. Physics, Brown University, Providence, Rhode Island
1976 B.A. Physics, Pomona College, Claremont, California

Professional Experience

1998-Present Independent Consultant

Individual consulting practice emphasizing the statistical analysis of environment and energy data with an emphasis on how data and statistics are properly used to make scientific inferences. Mr. Crawford provides support on statistical, data analysis, and modeling problems related to ambient air quality data and emissions from mobile and stationary sources.

Ambient Air Quality and Mobile Source Emissions – Mr. Crawford has worked with Sierra Research on elevated ambient CO and PM concentrations in Fairbanks AK and Phoenix AZ, including the effect of meteorological conditions on ambient concentrations, the relationship of concentrations to source inventories, and the use of non-parametric techniques to infer source location from wind speed and direction data. Ongoing work is employing Principal Components Analysis to elucidate the relationship between meteorology and $PM_{2.5}$ concentrations in Fairbanks. In the past year, this work led to creation of the AQ Alert System, a tool used by air quality staff to track $PM_{2.5}$ monitor concentrations during the day and to prepare AQ alerts over the next 3 days based on the meteorological forecast.

In past work for Sierra, he has also conducted studies of fuel effects on motor vehicle emissions for Sierra. For CRC, he determined the relationship between gasoline volatility and oxygen content on tailpipe emissions of late model vehicles at FTP and cold-ambient temperatures. For SEMPRA, he determined the relationship between CNG formulation and tailpipe emissions of criteria pollutants and a range of air toxics. Other work has included the design of vehicle surveillance surveys and determination of sample sizes, development of screening techniques similar to discriminant functions to improve the efficiency of vehicle recruitment, the analysis of vehicle failure rates measured in inspection & maintenance programs, and the statistical evaluation of data collected on freeway speeds using automated sensors.

Stationary Source Emissions – Over the past 5 years, Mr. Crawford has worked with AEMS, LLC on EPA's MACT and CISWI rulemakings for Portland Cement plants, in which significant issues related to data quality, data reliability, and emissions variability are evident. Key issues include the need to properly account for uncertainty and emissions variability in setting emission standards. He also supported AEMS in the

current EPA rulemaking on reporting of greenhouse gas emissions from semiconductor facilities, where the proper characterization of emission control device performance was a key issue. He is currently supporting AEMS in a regulatory process to re-determine emission standards for an industrial facility where the new standard will be enforced by continuous emissions monitoring (CEMS). At issue is how to set the standard in such a way that there will be no more than a small, defined risk that 30-day emission averages will exceed the limitations while emissions remain well-controlled .

Advanced Combustion Research – In recent work for Oak Ridge National Laboratory, Mr. Crawford conducted a series of statistical studies on the fuel consumption and emissions performance of Homogenous Charge Compression Ignition (HCCI) engines. One of these studies was for CRC, in which fuel chemistry impacts were examined in gasoline HCCI. In HCCI, the fuel is atomized and fully-mixed with the intake air charge outside the cylinder, inducted during the intake stroke, and then compressed to the point of spontaneous combustion. The timing of combustion is controlled by heating of the intake air. If R&D work can demonstrate a sufficient understanding of how fuel properties influence engine performance, the HCCI combustion strategy potentially offers the fuel economy benefit of a diesel engine with inherently lower emissions.

1979-1997 Energy and Environmental Analysis, Inc., Arlington, VA. Director & Partner (from 1989).

Primary work areas: Studies of U.S. energy industries for private and institutional clients emphasizing statistical analysis, business planning and computer modeling/forecasting. Responsible for the EEA practice area that provided strategic planning and forecasting services to major energy companies. Primary topical areas included: U.S. energy market analysis and strategic planning; gas utility operations; and natural gas supply planning.

U.S. Energy Market Analysis

During 1995-1997, Mr. Crawford directed EEA's program to provide comprehensive energy supply and demand forecasting for the Gas Research Institute (GRI) in its annual Baseline Projection of U.S. Energy Supply and Demand. Services included: development of U.S. energy supply, demand, and price forecasts; sector-specific analyses covering energy end-use (residential, commercial, industrial, transportation), electricity supply, and natural gas supply and transportation; and the preparation of a range of publications on the forecasts and energy sector trends.

From 1989 through 1997, he directed the use of EEA's Energy Overview Model in strategic planning and long-term market analysis for a client base of major energy producers, pipelines, and distributors in both the United States and Canada. The Energy Overview Model was used under his direction as the primary analytical basis for the 1992 National Petroleum Council study The Potential for Natural Gas in the United States. Mr. Crawford also provided analysis for clients on a wide range of other energy market issues, including negotiations related to an LNG import project intended to serve U.S. East Coast markets. This work assessed the utilization and economic value of seasonal

gas deliverability in order to develop LNG pricing formulas and evaluate the project's viability.

Other topical areas of work during his period of employment with EEA include:

Gas Load Analysis and Utility Operations – Principal investigator in a multi-year research program for the Gas Research Institute (GRI) that examined seasonal gas loads, utility operations, and the implications for transmission and storage system reliability and capacity planning.

Gas Transmission and Storage – Principal investigator for a study of industry plans for expansion of underground gas storage capacity in the post-Order 636 environment, including additions of depleted-reservoir and salt-formation storage, an engineering analysis of capital and operating costs for the projects, and unbundled rates for new storage services.

Natural Gas Supply Planning – Mr. Crawford was EEA's senior manager and lead analyst on gas supply planning issues for both pipeline and distribution companies, which included technical and analytic support in development and justification of gas supply strategies; and identification of optimal seasonal supply portfolios for Integrated Resource Planning proceedings.

Transportation Systems Research

Mr. Crawford also had extensive experience in motor vehicle fuel economy and emissions while at EEA. He participated for five years in a DOE research program on fuel economy, with emphasis on the evaluation of differences between laboratory and on-road fuel economy. His work included analysis of vehicle use databases to understand how driving patterns and ambient (environmental) conditions influence actual on-road fuel economy. He also developed a software system to link vehicle certification data systems to vehicle inspection and testing programs and participated in a range of studies on vehicle technology, fuel economy, and emissions for DOE, EPA, and other governmental agencies.

SELECTED PUBLICATIONS (emissions and motor vehicle-related topics)

Statistical Assessment of $PM_{2.5}$ and Meteorology in Fairbanks, Alaska: 2013 Update. Crawford and Dulla. Prepared for the Alaska Department of Environmental Conservation. (forthcoming).

Statistical Assessment of $PM_{2.5}$ and Meteorology in Fairbanks, Alaska. Crawford and Dulla. Prepared for the Alaska Department of Environmental Conservation. March 2012.

Principal Component Analysis: Inventory Insights and Speciated $PM_{2.5}$ Estimates. Crawford. Presentation at Air Quality Symposium 2011, Fairbanks and North Star Borough, Fairbanks, AK. January 2011.

Influence of Meteorology on $PM_{2.5}$ Concentrations in Fairbanks Alaska: Winter 2008-2009. Crawford. Presentation at Air Quality Symposium 2009, Fairbanks and North Star Borough, Fairbanks, AK. July 2009.

Analysis of the Effect of Fuel Chemistry and Properties on HCCI Engine Operation: A Re-Analysis Using a PCA Representation of Fuels. Bunting and Crawford. 2009. Draft Report (CRC Project AFVL13C)

The Chemistry, Properties, and HCCI Combustion Behavior of Refinery Streams Derived from Canadian Oil Sands Crude. Bunting, Fairbridge, Mitchell, Crawford, et al. 2008. (SAE 08FFL 28)

The Relationships of Diesel Fuel Properties, Chemistry, and HCCI Engine Performance as Determined by Principal Components Analysis. Bunting and Crawford. 2007. (SAE 07FFL 64).

Review and Critique of Data and Methodologies used in EPA Proposed Utility Mercury MACT Rulemaking, prepared by AEMS and RWCrawford Energy Systems for the National Mining Association. April 2004.

PCR+ in Diesel Fuels and Emissions Research. McAdams, Crawford, Hadder. March 2002. ORNL/TM-2002/16.

A Vector Approach to Regression Analysis and its Application to Heavy-duty Diesel Emissions. McAdams, Crawford, Hadder. November 2000. ORNL/TM-2000/5.

A Vector Approach to Regression Analysis and its Application to Heavy-duty Diesel Emissions. McAdams, Crawford, Hadder. June 2000. (SAE 2000-01-1961).

Reconciliation of Differences in the Results of Published Shortfall Analyses of 1981 Model Year Cars. Prepared by Energy and Environmental Analysis, Inc. for the U.S. Department of Energy under Contract DE-AC01-79PE-70045. October 1985

Short Test Results on 1980-1981 Passenger Cars from the Arizona Inspection and Maintenance Program. Darlington, Crawford, Sashihara. August 1984.

Seasonal and Regional MPG as Influenced by Environmental Conditions and Travel Patterns. Prepared by Energy and Environmental Analysis, Inc. for the U.S. Department of Energy under Contract DE-AC01-79PE-70045. March 1983.

Comparison of EPA and On-Road Fuel Economy – Analysis Approaches, Trends, and Impacts. McNutt, Dulla, Crawford, McAdams, Morse. June 1982. (SAE 820788)

Regionalization of In-Use Fuel Economy Effects. Prepared by Energy and Environmental Analysis, Inc. for the U.S. Department of Energy under Contract DE-AC01-79PE-70032. April 1982.

1985 Light-Duty Truck Fuel Economy. Duleep, Kuhn, Crawford. October 1980. (SAE 801387)

PROFESSIONAL AFFILIATIONS

Member, Society of Automotive Engineers.

HONORS AND AWARDS

2006 Barry D. McNutt Award for Excellence in Automotive Policy Analysis. Society of Automotive Engineers.

US Patent 7018524 (McAdams, Crawford, Hadder, McNutt). Reformulated diesel fuels for automotive diesel engines which meet the requirements of ASTM 975-02 and provide significantly reduced emissions of nitrogen oxides (NO_x) and particulate matter (PM) relative to commercially available diesel fuels.

US Patent 7096123 (McAdams, Crawford, Hadder, McNutt). A method for mathematically identifying at least one diesel fuel suitable for combustion in an automotive diesel engine with significantly reduced emissions and producible from known petroleum blend stocks using known refining processes, including the use of cetane additives (ignition improvers) and oxygenated compounds.

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3_B_ADF_GE Responses (Page 205 – 210)

194. Comment: **Robert Crawford's Resume**

Agency Response:
This is submittal one of three of Robert Crawford's resume to the ADF docket. It does not constitute an objection or suggestion on the proposal.

EXHIBIT B

BEFORE THE
CALIFORNIA AIR RESOURCES BOARD

In re:	)
	)
Proposed Regulation on the Commercialization of Alternative Diesel Fuels (Public Hearing Scheduled for March 20, 2014)	)
	)

Declaration of James M. Lyons

I, James M. Lyons, declare and state as follows:

1. I am an engineer with training and expertise in motor vehicle fuels, automotive emissions control, and automotive air pollution. I am a Senior Partner of Sierra Research, Inc. ("Sierra"), an environmental consulting firm located at 1801 J Street, Sacramento, California. Sierra specializes in research and regulatory matters pertaining to air pollution control, and does work for both governmental and private sector clients. I have been employed at Sierra Research since 1991. I received a B.S. degree in Chemistry from the University of California, Irvine, and a M.S. Degree in Chemical Engineering from the University of California, Los Angeles. Before joining Sierra in 1991, I was employed by the State of California in the Mobile Source Division of the California Air Resources Board ("CARB").

I. Introduction, Qualifications, and Materials Considered

2. I have prepared this Declaration and the analysis it contains for Growth Energy. I hold the opinions expressed in this Declaration with a reasonable degree of engineering and scientific certainty. I plan to request an opportunity to testify before CARB at the public hearing scheduled for this matter, so that I may answer any questions concerning my opinions and the analysis and sources on which I have based those opinions. I also request that CARB review and

respond to each part of the analysis and opinions presented in this Declaration before deciding what action to take on the CARB staff's proposed alternative diesel fuel ("ADF") regulation.

3. During my career, I have worked on many projects related to the following areas: (1) the assessment of emissions from on- and non-road mobile sources, including ships and locomotives; (2) analyses of the unintended consequences of regulatory actions; and (3) the feasibility of compliance with air quality regulations. I have also studied how the use of biodiesel fuels can influence exhaust emissions of oxides of nitrogen ("NOx") when used in vehicles and engines operated in California, and I have prepared and filed declarations regarding that issue in *POET LLC et al. v. California Air Resources Board*, an action in which I was a co-petitioner.

4. I have testified as an expert under state and federal court rules in cases involving CARB regulations for gasoline, Stage II vapor recovery systems and their design, combustion chamber system design, and issues related to emissions from heavy-duty vehicles and engines. While at Sierra I have acted as a consultant on automobile air pollution control matters for CARB and other governmental organizations. I am a member of the American Chemical Society and the Society of Automotive Engineers and have co-authored nine peer-reviewed monographs concerned with automotive emissions, including greenhouse gases and their control. In addition, over the course of my career, I have conducted peer-reviews of numerous papers related to a wide variety of issues associated with pollutant emissions and air quality. My résumé is attached as Attachment A.

5. I have reviewed a report being filed along with this Declaration by Growth Energy that has been prepared by Mr. Robert Crawford of Rincon Ranch Consulting, entitled *NOx Emissions Impact of Soy- and Animal-based Biodiesel Fuels: A Re-Analysis* (December

2013). I have also studied the CARB Initial Statement of Reasons ("ISOR" or "Staff Report") released to support the proposed ADF regulation, and the studies cited in the ISOR that are pertinent to Mr. Crawford's analysis. The additional materials I have considered to prepare this Declaration are identified as references.

6. Mr. Crawford's report examines the empirical basis for the CARB staff's claims that the use of biodiesel in California is unlikely to warrant environmental mitigation, and that the use of biodiesel blends below the ten percent blend level (B10) in California pursuant to the proposed ADF regulation will not result in increases in NOx emissions.

7. Mr. Crawford's report applies generally accepted methods of data analysis and demonstrates expertise in the subject-matter of the report; Mr. Crawford is an expert in the field in which he opines in his report; and his report is the type of analysis on which experts in the field of automotive emissions control rely.

II. Analysis and Opinions

A. Increases in NOx Emissions from Biodiesel Blends Below B10

8. As explained in detail in Mr. Crawford's report, a proper statistical analysis of the available emissions data relied upon by CARB staff in developing the proposed ADF regulation demonstrates that statistically significant increases in NOx emissions will result from biodiesel blends that contain less than ten percent biodiesel, including at the five percent level (B5) and below. In addition, Mr. Crawford's report demonstrates that NOx emissions increase in direct proportion of the amount of biodiesel in a blend and there is not, as CARB staff claims, a "threshold" below which biodiesel use in a blend will not increase NOx emissions. Given this, as I explain below in more detail, CARB staff should be proposing a Significance Level of zero, rather than ten percent, for biodiesel. Given the issues identified with the CARB staff analysis of

ADF B3-93

biodiesel impacts on NOx emissions by Mr. Crawford, CARB has no credible scientific basis upon which to adopt the ADF regulation as proposed with the biodiesel Significance Level set at ten percent.

ADF B3-93 cont.

9. CARB staff presents, in Figures B.2 and B.3 of the ISOR, regressions of all the available emissions data considered by CARB staff in developing the proposed ADF regulation. Based on Mr. Crawford's findings, the slopes of these regression lines can be used to calculate the increases in NOx emissions expected from the use of soy- and animal-based biodiesel as a function of biodiesel content in the blend. The values calculated for soy- and animal-based biodiesel at selected blends levels over the range from one percent to twenty percent are shown in Table 1.

ADF B3-94

Table 1
Expected Increases In NOx Emissions from Biodiesel
Use Based on Available Emissions Data Considered by CARB Staff

	Percentage Increase in NOx Emissions	
Biodiesel Blend Level %	Soy-Based	Animal-Based
1	0.2	0.09
2	0.4	0.18
3	0.6	0.27
4	0.8	0.36
5	1	0.45
10	2	0.90
20	4	1.80

10. As shown in Table 1, the magnitude of the NOx increase for animal-based biodiesel is approximately half that observed for soy-based biodiesel. As also shown in Table 1, the emissions data considered by CARB show that increases in NOx emissions between about one and two percent occur at the proposed B10 significance threshold.

ADF B3-95

B. The "Effective Blend Level" Concept Provides No Assurance Against Increases in NOx Emissions Due to Biodiesel Use

11. The proposed ADF regulation relies on a concept called the "Effective Blend Level" (EB) for biodiesel to determine when mitigation would be required. The formula proposed by CARB staff for calculating the Effective Blend Level for biodiesel is found in proposed Section 2293.6(a) and is reproduced below.

$$EB = 100 \times \left[\frac{NBV - 0.5LN - 0.73RD - VM - 0.55AB}{TCV}\right]$$

As specified in Section 2293.6(a), the above formula is to be used to compute an annual average statewide value for the Effective Blend Level relative to the total volume of fuel used in compression ignition engines excluding alternative fuels such as natural gas and liquefied petroleum gas ("TCV") in the state during that year.

12. The calculation begins with establishing the net volume of biodiesel of all types used in California *excluding biodiesel used in blends of five percent or less* (NBV) — a step that has no scientific basis, as demonstrated by Mr. Crawford's analysis, and that, on its own, completely invalidates the use of the EB metric for the intended purpose. The NBV value is then further reduced by subtracting 50% of the volume of low NOx Diesel (LN) used statewide and 73% of the volume of renewable Diesel used statewide. The remainder is then further reduced by subtracting the volume of biodiesel of all types used in blends where steps have been taken to voluntarily mitigate NOx increases (VM) and then again by subtracting 55% of the volume of animal-based biodiesel (AB) to account for the smaller magnitude of the NOx emission increases observed with that fuel.[1] The final value is then divided by TCV (i.e., the total volume of fuel

[1] Those voluntary mitigation measures are assumed to have been taken before the so-called "Significance Level" is reached and mitigation would be required under the staff's proposal. *See* ¶ 13.

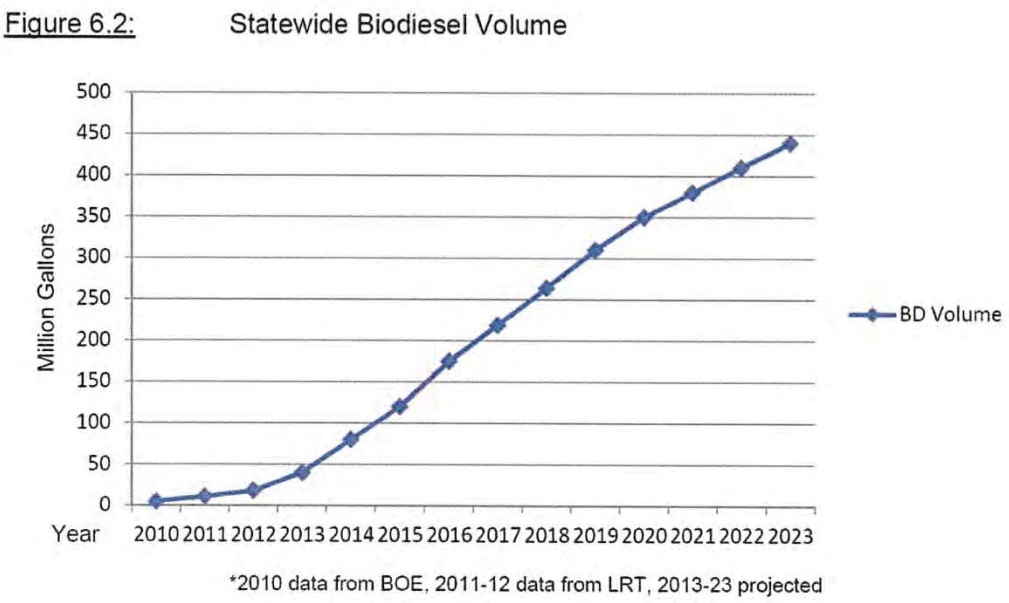
used in compression ignition engines excluding alternative fuels such as natural gas and liquefied petroleum gas in the state during that year) and multiplied by 100 to yield the Effective Blend Level on a percentage basis.

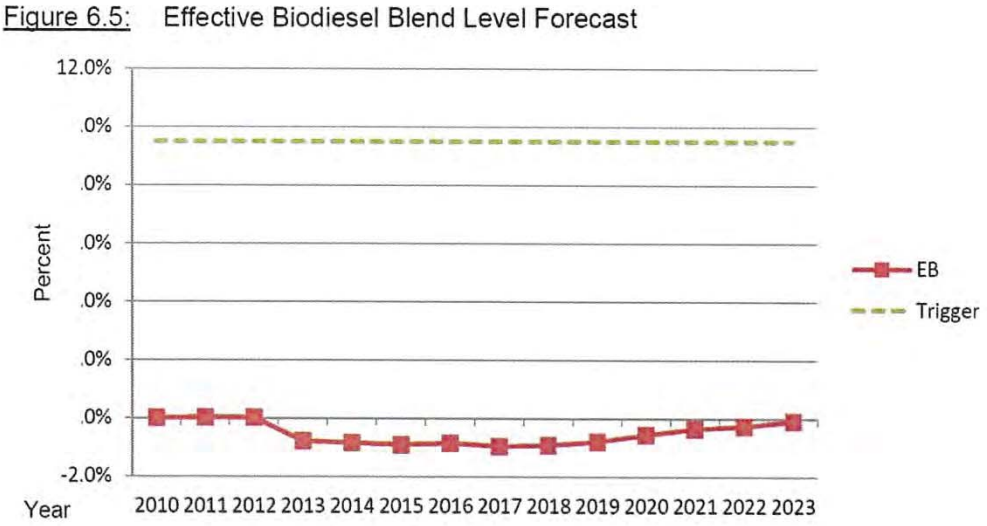
13. As specified in proposed Section 2293.5(c)(4), mitigation of NOx increases associated with biodiesel would be required only when the value of EB reaches 9.5 percent, which is 95% of the 10% Significance Level proposed for biodiesel.

14. There are a number of specific problems with the concept and calculation of the predicted Effective Blend Level that create the potential for significant increases in NOx emissions to result from the use of biodiesel in California; these are explained in detail below and should be addressed by CARB. As an initial matter, however, the overall problem with the EB concept will allow massive increases in the amount of biodiesel used in California without requiring any mitigation of the associated increase in NOx emissions. This can be seen readily by comparing CARB staff's projections of biodiesel use in California (Figure 6.2 of the ISOR) with CARB staff's projections regarding the Effective Blend Level for biodiesel (Figure 6.5 of the ISOR). Those two figures are reproduced below in Figure 1. As can been seen, despite the forecast nine-fold increase in annual biodiesel use in California from 50 million to 450 million gallons from 2013 to 2023 shown in Figure 6.2 of the ISOR, the forecast Effective Blend Level of biodiesel **decreases** to less than zero over virtually all of the period in question — meaning that, under the CARB staff's proposal, no mitigation of the increase in NOx emissions in California from biodiesel use will ever occur. CARB needs to confront and eliminate the EB concept from the staff's proposal, in light of this very simple demonstration of why the EB concept will not protect the environment against increases in NOx emissions.

ADF B3-96

Figure 1. CARB Biodiesel Forecasts





Source: CARB Initial Statement of Reasons. Note that Figure 6.5 is reproduced directly from the ISOR, which is missing some increments on the y-axis.

15. Next, CARB needs to modify the proposed ADF regulation in order to address CARB staff's faulty assumption that biodiesel blends of up to five percent will have no impact on NOx emissions. With respect to five percent blends, CARB staff states on page ES-3 of the Staff

ADF B3-97

Report that "biodiesel used in blends at B9 or below, including the B5 (B0 to B5) in predominant use today, does not increase NOx." The Staff Report also attempts to justify the exclusion of five percent blends from the EB calculation by arbitrarily excluding these blends from the ADF regulation. That assertion is undercut by the Staff Report's frank and correct admission on page 51 that "[g]iven the significant price premium for higher biodiesel blends such as B20 or B100, it is highly unlikely that operators of heavy-duty, legacy diesel fleets would opt to use the more expensive, higher biodiesel blends when comparable, lower cost conventional CARB diesel or B5 blends are readily available."

ADF B3-97 cont.

16. As noted above, Mr. Crawford's analysis demonstrates that statistically significant increases in NOx emissions will occur from the use of five percent biodiesel blends and, as Table 1 shows, the available emissions data relied upon by CARB staff indicate that at the five percent blend level, biodiesel use is expected to increase NOx emission by between about 0.5 and one percent. There is no doubt that unmitigated NOx emission increases of this magnitude have the potential to create significant adverse environmental impacts in areas of California with severe air quality problems.

ADF B3-98

17. It is also important for CARB to understand the import of the staff's prediction that biodiesel blends of five percent or less will be the primary means by which biodiesel will be used in California. As the Staff Report states on page 30:

> Staff has communicated with many of the stations that sell biodiesel as well as the major terminal operators in the state, and has found that the vast majority of the biodiesel currently being sold in California and expected to be sold in the future is sold as blends of B5 or less.

ADF B3-99

The fact that most biodiesel used in California will be sold as blends of five percent biodiesel or less, coupled with the fact that – as Mr. Crawford has explained – the available data show statistically significant increases in NOx emissions from such blends, means that biodiesel use in

California under the proposed ADF regulation will result in unmitigated increases in NOx emissions. Again, the critical nature of the CARB staff's invalid assumption about the NOx impacts of blends at or below five percent simply cannot be ignored by CARB.

ADF B3-99 cont.

18. Even if it were correct that blends of B5 and less have no impact on NOx emissions, the EB calculation double-counts for the supposedly benign effect of those blends, and therefore makes mitigation even more unlikely. This can be illustrated by noting that CARB staff estimates that 450 million gallons per year of biodiesel will be used in California in 2023. (See Figure 6.2 of the Staff Report.) A recent California Energy Commission forecast[2] for total Diesel use in California in 2023 is about 4 billion gallons. On that basis, and without discounting for low NOx, renewable Diesel, or voluntary mitigation, the actual Effective Blend Level would be 11.25 percent and mitigation would be required for at least some biodiesel blends under the proposed ADF. Under CARB staff's approach, however, if a substantial portion of that biodiesel — for example, 50 percent — is five percent or lower blends, the Effective Blend Level drops to 5.6 percent and no mitigation of any kind is required for any biodiesel blends. That result is clearly incorrect, and the EB calculation must be modified to include, rather than exclude, B5 blends.

ADF B3-100

19. Another fundamental problem with the proposed EB calculation is that it is based on annual statewide average fuel use. NOx emissions have local and immediate impacts on air quality, with the questions of when and where they occur in the state being of critical importance with respect to the significance of those impacts. It follows directly that mitigation of NOx increases associated with biodiesel use must occur in the same area at the same time if air quality

ADF B3-101

[2] See *http://www.energy.ca.gov/2011publications/CEC-600-2011-007/CEC-600-2011-007-SD.pdf*.

impacts are to be avoided. However, the EB completely fails to provide this assurance because CARB staff has either (1) ignored that reductions in NOx emissions from mitigation must take place at the same time and in the same area as NOx increases from biodiesel use, or (2) without support from anything in the rulemaking file, assumed that mitigation will occur in the same area and at the same time as the increases in NOx emissions.

ADF B3-101 cont.

20. To illustrate the problems the EB creates for mitigation, consider, for example, that under the proposed ADF regulation, increases in NOx emissions could occur from trucks operating on biodiesel in Los Angeles during August and exacerbate already high ambient ozone levels in that area. In turn, this increase in NOx emissions could be "mitigated" by reductions in NOx emissions from trucks operating on renewable diesel in the San Francisco area during December, when high ozone levels are not a problem. In this example, the EB concept would allow residents of Los Angeles to suffer adverse environmental impacts while the residents of San Francisco would realize no environmental benefit. Clearly the approach to mitigation designed into the EB concept by CARB staff makes no sense.

ADF B3-102

C. CARB Staff's Assumption that Biodiesel Use Will not Increase Emissions from New Technology Diesel Engines Is Not Adequately Supported

21. In the Staff Report, CARB staff makes frequent statements regarding the impact of biodiesel on NOx emissions from "new technology diesel engines" (or "NTDEs"). For example, on page ES-3 of the ISOR, the staff states categorically that "use of biodiesel in 2010-compliant engines and other so-called 'New Technology Diesel Engines' does not increase NOx, regardless of the biodiesel blend level." Only one reference, Lammert et al.,[3] is provided in the staff report

ADF B3-103

[3] Lammert, M., McCormick, R., Sindler, P. and Williams, A., "Effect of B20 and Low Aromatic Diesel on Transit Bus NOx Emissions Over Driving Cycles with a Range of Kinetic Intensity," *SAE Int. J. Fuels Lubr.* 5(3):2012,

(Continued...)

to support this and other, analogous, statements by CARB staff. As CARB staff acknowledges, this single study involved chassis dynamometer testing of only two urban buses with NTDEs, with both engines being the same model produced by the same manufacturer. The extrapolation of that limited testing to the entire population of heavy-duty Diesel vehicles with NTDEs used in different applications and with different engine designs produced by a number of different manufacturers is simply not credible or reliable.

ADF B3-103 cont.

22. In addition, the CARB staff fails to acknowledge the following statement made by the authors of the Lammert study about the measurement of NOx emissions: "For much of the cycle[,] NOx would be at or near the detection limit of the laboratory equipment which resulted in a 95 percent confidence interval that was high relative to the value of the cycle emissions." That effect, which can be clearly seen in Figures 10 and 11 of the Lammert study, renders the claim that there was no statistically significant increase in NOx emissions observed from the use of biodiesel in NTDEs an artifact attributable to the lack of sensitivity of the NOx measurement instrumentation used in the study.

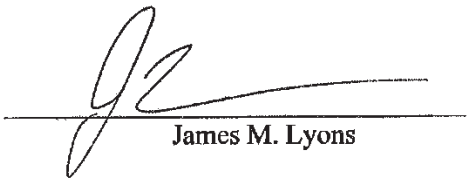
ADF B3-104

23. In sum, the CARB staff's unequivocal statements regarding the impact of biodiesel on NOx emissions from all vehicles with NTDEs is simply not reasonable based on data from (1) a single study that (2) that tested only two urban buses equipped with the same engine and (3) used instrumentation that was, at best, barely able to measure NOx emissions from the test vehicles in general, and clearly was not sensitive enough to reliably detect changes in NOx emissions due to use of different fuels. Nothing else in the rulemaking file supports the CARB staff's claim that there will not be increased NOx emissions from the use of biodiesel in NTDEs.

ADF B3-105

I declare under penalty of perjury under the laws of California that the foregoing is true and correct to the best of my knowledge and belief.

Executed this 12th day of December 2013 at Sacramento, California.



James M. Lyons

3_B_ADF_GE Responses (Page 211 – 224)

195. Comment: **ADF B3-98, ADF B3-99, and ADF B3-103 through ADF B3-105**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

196. Comment: **ADF B3-93**
The comment questions the decision of ARB staff to choose a significance level threshold at B10.

Agency Response:
The comment is specific to the 2013 proposal, and is no longer relevant. The provisions discussed are not in the 2015 ADF regulation.

197. Comment: **ADF B3-94**
The comment summarizes results from Mr. Crawford's regression line analysis.

Agency Response:
The comment does not constitute an objection or recommendation regarding the 2015 ADF regulation.

198. Comment: **ADF B3-95**
The comment summarizes the commenter's analysis and results based on the data as of early 2014.

Agency Response:
The comment does not constitute an objection or recommendation regarding the 2015 ADF regulation.

199. Comment: **ADF B3-96**
The comment describes specific issues the commenter has with the Effective Blend Level.

Agency Response:
The comment is specific to the 2013 proposal, and is no longer relevant. The provisions discussed are not in the 2015 ADF regulation.

200. Comment: **ADF B3-97**
The comment requests ARB to re-evaluate NOx emissions from biodiesel blends up to five percent, as well as the representation of B5 in the EB equation.

Agency Response:
The comment is specific to the 2013 proposal, and is no longer relevant. The provisions discussed are not in the 2015 ADF regulation.

201. Comment: **ADF B3-100**
The comment states concerns regarding the Effective Blend calculation.

Agency Response:
The comment is specific to the 2013 proposal, and is no longer relevant. The provisions discussed are not in the 2015 ADF regulation.

202. Comment: **ADF B3-101**
The comment states concerns regarding the Effective Blend calculation.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed are no longer in the 2015 ADF regulation

203. Comment: **ADF B3-102**
The comment states concerns regarding the Effective Blend calculation.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed are no longer in the 2015 ADF regulation.

ATTACHMENT A

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research

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Résumé

James Michael Lyons

Education

1985, M.S., Chemical Engineering, University of California, Los Angeles

1983, B.S., Cum Laude, Chemistry, University of California, Irvine

Professional Experience

4/91 to present — Senior Engineer/Partner/Senior Partner
Sierra Research

Primary responsibilities include oversight and execution of complex analyses of the emission benefits, costs, and cost-effectiveness of mobile source air pollution control measures. Mr. Lyons has developed particular expertise with respect to the assessment of control measures involving fuel reformulation, fuel additives, and alternative fuels, as well as accelerated vehicle/engine retirement programs, the deployment of advanced emission control systems for on- and non-road gasoline- and Diesel-powered engines, on-vehicle evaporative and refueling emission control systems, and Stage I and Stage II service station vapor recovery systems. Additional duties include assessments of the activities of federal, state, and local regulatory agencies with respect to motor vehicle emissions and reports to clients regarding those activities. Mr. Lyons has extensive litigation experience related to air quality regulations, product liability, and intellectual property issues.

7/89 to 4/91 — Senior Air Pollution Specialist
California Air Resources Board

Supervised a staff of four professionals responsible for identifying and controlling emissions of toxic air contaminants from mobile sources and determining the effects of compositional changes to gasoline and diesel fuel on emissions of regulated and unregulated pollutants. Other responsibilities included development of new test procedures and emission standards for evaporative and running loss emissions of hydrocarbons from vehicles; overseeing the development of the state plan to control toxic emissions from motor vehicles; and reducing emissions of CFCs from motor vehicles.

4/89 to 7/89 — Air Pollution Research Specialist
California Air Resources Board

Responsibilities included identification of motor vehicle research needs; writing requests for proposals; preparation of technical papers and reports; as well as monitoring and overseeing research programs.

9/85 to 4/89 — Associate Engineer/Engineer
California Air Resources Board

Duties included analysis of vehicle emissions data for trends and determining the effectiveness of various types of emissions control systems for both regulated and toxic emissions; determining the impact of gasoline and diesel powered vehicles on ambient levels of toxic air contaminants; participation in the development of regulations for "gray market" vehicles; and preparation of technical papers and reports.

Professional Affiliations

American Chemical Society
Society of Automotive Engineers

Selected Publications (Author or Co-Author)

"Review of CARB Staff Analysis of 'Illustrative' Low Carbon Fuel Standard (LCFS) Compliance Scenarios," Sierra Research Report No. SR2012-02-01, prepared for the Western States Petroleum Association, February 20, 2012.

"Review of CARB On-Road Heavy-Duty Diesel Emissions Inventory," Sierra Research Report No. SR2010-11-01, prepared for The Ad Hoc Working Group, November 2010.

"Identification and Review of State/Federal Legislative and Regulatory Changes Required for the Introduction of New Transportation Fuels," Sierra Research Report No. SR2010-08-01, prepared for the American Petroleum Institute, August 2010.

"Technical Review of EPA Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis for Non-GHG Pollutants," Sierra Research Report No. SR2010-05-01, prepared for the American Petroleum Institute, May 2010.

"Effects of Gas Composition on Emissions from Heavy-Duty Natural Gas Engines," Sierra Research Report No. SR2010-02-01, prepared for the Southern California Gas Company, February 2010.

"Effects of Gas Composition on Emissions from a Light-Duty Natural Gas Vehicle," Sierra Research Report No. SR2009-11-01, prepared for the Southern California Gas Company, November 2009.

"Technical Review of 2009 EPA Draft Regulatory Impact Analysis for Non-GHG Pollutants Due to Changes to the Renewable Fuel Standard," Sierra Research Report No. SR2009-09-01, prepared for the American Petroleum Institute, September 2009.

"Effects of Vapor Pressure, Oxygen Content, and Temperature on CO Exhaust Emissions," Sierra Research Report No. 2009-05-03, prepared for the Coordinating Research Council, May 2009.

"Technical Review of 2007 EPA Regulatory Impact Analysis Methodology for the Renewable Fuels Standard," Sierra Research Report No. 2008-09-02, prepared for the American Petroleum Institute, September 2008.

"Impacts of MMT Use in Unleaded Gasoline on Engines, Emission Control Systems, and Emissions," Sierra Research Report No. 2008-08-01, prepared for McMillan Binch Mendelsohn LLP, Canadian Vehicle Manufacturers' Association, and Association of International Automobile Manufacturers of Canada, August 2008.

"Attachment to Comments Regarding the NHTSA Proposal for Average Fuel Economy Standards Passenger Cars and Light Trucks Model Years 2011-2015, Docket No. NHTSA-2008-0089," Sierra Research Report No. SR2008-06-01, prepared for the Alliance of Automobile Manufacturers, June 2008.

"Evaluation of California Greenhouse Gas Standards and Federal Energy Independence and Security Act – Part 1: Impacts on New Vehicle Fuel Economy," SAE Paper No. 2008-01-1852, Society of Automotive Engineers, 2008.

"Basic Analysis of the Cost and Long-Term Impact of the Energy Independence and Security Act Fuel Economy Standards," Sierra Research Report No. SR 2008-04-01, April 2008.

"The Benefits of Reducing Fuel Consumption and Greenhouse Gas Emissions from Light-Duty Vehicles," SAE Paper No. 2008-01-0684, Society of Automotive Engineers, 2008.

"Assessment of the Need for Long-Term Reduction in Consumer Product Emissions in South Coast Air Basin," Sierra Research Report No. 2007-09-03, prepared for the Consumer Specialty Products Association, September 2007.

"Summary of Federal and California Subsidies for Alternative Fuels," Sierra Research Report No. SR2007-04-02, prepared for the Western States Petroleum Association, April 2007.

"Analysis of IRTA Report on Water-Based Automotive Products," Sierra Research Report No. SR2006-08-02, prepared for the Consumer Specialty Projects Association and Automotive Specialty Products Alliance, August 2006.

"Evaluation of Pennsylvania's Implementation of California's Greenhouse Gas Regulations on Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2006-04-01, prepared for Alliance of Automobile Manufacturers, April 12, 2006.

"Evaluation of New Jersey's Adoption of California's Greenhouse Gas Regulations on Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2005-09-03, prepared for the Alliance of Automobile Manufacturers, September 30, 2005.

"Evaluation of Vermont's Adoption of California's Greenhouse Gas Regulations on Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2005-09-02, prepared for the Alliance of Automobile Manufacturers, September 19, 2005.

"Assessment of the Cost-Effectiveness of Compliance Strategies for Selected Eight-Hour Ozone NAAQS Nonattainment Areas," Sierra Research Report No. SR2005-08-04, prepared for the American Petroleum Institute, August 30, 2005.

"Evaluation of Connecticut's Adoption of California's Greenhouse Gas Regulations on Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2005-08-03, prepared for the Alliance of Automobile Manufacturers, August 26, 2005.

"Evaluation of New York's Adoption of California's Greenhouse Gas Regulations On Criteria Pollutants and Precursor Emissions," Sierra Research Report No. SR2005-07-04, prepared for the Alliance of Automobile Manufacturers, July 14, 2005.

"Review of MOVES2004," Sierra Research Report No. SR2005-07-01, prepared for the Alliance of Automobile Manufacturers, July 11, 2005.

"Review of Mobile Source Air Toxics (MSAT) Emissions from On-Highway Vehicles: Literature Review, Database, Development, and Recommendations for Future Studies," Sierra Research Report No. SR2005-03-01, prepared for the American Petroleum Institute, March 4, 2005.

"The Contribution of Diesel Engines to Emissions of ROG, NOx, and PM2.5 in California: Past, Present, and Future," Sierra Research Report No. SR2005-02-01, prepared for Diesel Technology Forum, February 2005.

"Fuel Effects on Highway Mobile Source Air Toxics (MSAT) Emissions," Sierra Research Report No. SR2004-12-01, prepared for the American Petroleum Institute, December 23, 2004.

"Review of the August 2004 Proposed CARB Regulations to Control Greenhouse Gas Emissions from Motor Vehicles: Cost Effectiveness for the Vehicle Owner or Operator – Appendix C to the Comments of The Alliance of Automobile Manufacturers," Sierra Research Report No. SR2004-09-04, prepared for the Alliance of Automobile Manufacturers, September 2004.

"Emission and Economic Impacts of an Electric Forklift Mandate," Sierra Research Report No. SR2003-12-01, prepared for National Propane Gas Association, December 12, 2003.

"Reducing California's Energy Dependence," Sierra Research Report No. SR2003-11-03, prepared for Alliance of Automobile Manufacturers, November 25, 2003.

"Evaluation of Fuel Effects on Nonroad Mobile Source Air Toxics (MSAT) Emissions: Literature Review, Database Development, and Recommendations for Future Studies," Sierra Research Report No. SR2003-10-01, prepared for American Petroleum Institute, October 3, 2003.

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"Benzene/Aromatic Measurements and Exhaust Emissions from Gasoline Vehicles," Paper No. 89-34B.4, presented at the 82nd Annual Meeting of the Air and Waste Management Association, Anaheim, CA, June 1989.

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3_B_ADF_GE Responses (Page 225 – 234)

204. Comment: **James Lyons' Resume**

Agency Response:
This is submittal two of three of James Lyons' resume to the ADF docket. It does not constitute an objection or suggestion on the proposal.

growth energy
America's Ethanol Supporters

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September 16, 2013

By Electronic Mail

Alexander Mitchell
Floyd Vergara
California Air Resources Board
Stationary Source Division
1001 I Street
Sacramento, California 95812

Re: Comments Regarding CARB's Alternative Diesel Fuels Rulemaking

Dear Sirs:

Growth Energy, an organization of ethanol producers and supporters, has a number of concerns with the Alternative Diesel Fuels (ADF) Regulations currently under development by the staff of the California Air Resources Board (CARB) which were the subject of a September 5th workshop held in Sacramento. These concerns, which are described in detail below, focus on the treatment of biodiesel and biodiesel blends currently being proposed by CARB staff. Overall, the provisions of the proposed ADF regulations would allow for the widespread use of biodiesel and biodiesel blends in California without adequately mitigating the resulting increases in emissions of oxides of nitrogen (NOx). The treatment being proposed by CARB staff for biodiesel and biodiesel blends is unacceptable in that it will result in adverse air quality impacts and violates several of the "underlying principles" in the February 15, 2013, CARB White Paper concerning its conceptual approach to the regulation of alternative diesel fuels, including:[1]

1. Protection of public health;

2. Preservation or improvement of air quality; and

3. Reliance on the best scientific knowledge available.

Given the above, Growth Energy urges CARB staff to revise the proposed ADF regulations to eliminate the potential for biodiesel use in California to result in increased emissions, degraded air quality and adverse impacts on public health.

[1] See page 3 of CARB's White Paper "Discussion of Conceptual Approach to Regulation of Alternative Diesel Fuels", February 15, 2013 which is available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20130212ADFRegConcept.pdf

1. The Proposed ADF Regulation Incorrectly Ignores Increases in NOx Emissions Associated with Use of Biodiesel Blends

As currently drafted, the proposed ADF regulation fails to require any mitigation for increases in NOx emissions associated with the use of biodiesel until total biodiesel usage in the state amounts to at least 10% of all fuel used in diesel engines in California on an annual basis.[2] While the potential for increased NOx emissions due to this arbitrarily established "significance level" for biodiesel use is discussed in Section 2 below, its basic premise appears to be an assumption that there are no NOx emissions associated with the use of biodiesel blends at or below the B10 level. In support of the inaccurate assumption that there is some threshold level below which biodiesel use will not increase emissions, CARB cites its White Paper, which states:[1]

> *Furthermore, for purposes of this rulemaking B5 blends will be considered a legal California diesel fuel with no emissions mitigation required.*

This arbitrary threshold is not supported by any data or analysis, and we are unaware of any published analysis of emissions test data that supports the assumptions that there are no increases in NOx emissions at either the B5 or up to the B10 levels.

ADF B3-106

In contrast, a preliminary analysis of data from CARB's most recently funded biodiesel testing program[3] demonstrates that NOx emissions would increase significantly at the B5 and B10 levels in at least some engines and for some biodiesel types. Here, the term "significant" means both that the NOx increase is statistically significant and that it is large enough to be of concern. Although the fact that CARB has not made all of the emissions data from this testing program publically available makes analysis difficult, results of a preliminary analysis are shown in Table 1 below for a 2006 model-year Cummins heavy-duty diesel engine. As shown, the relationship between increasing biodiesel content and increased NOx emissions is statistically significant at the 95% confidence level in all cases for soy-based biodiesel and at the 90% confidence level or better for animal-based biodiesel.

ADF B3-107

Further, the R^2 statistics for soy-based fuels show that the emissions effect of biodiesel is almost perfectly linear with increasing biodiesel content. Although not as high because the emissions effect is smaller and measurement errors are relatively larger in comparison to the trend, the R^2 statistics for the animal-based fuels also clearly establish a linear increase in NOx emissions with increasing biodiesel content. Because the slope or the regression equations are statistically significant in all cases and the R^2 statistics are high, there is no evidence in the data for the Cummins engine of the "threshold effect" that CARB staff claims which purports that biodiesel content has to reach the B5 or B10 level before NOx emissions begin to increase.

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[2] See slide 18 of the staff presentation for the September 5th workshop which is available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20130905ADFWorkshopPresentation.pdf

[3] Available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20111013_CARB%20Final%20Biodiesel%20Report.pdf

PRELIMINARY ANALYSIS SUBJECT TO REVISON

Table 1. 2006 Cummins Engine (Dynamometer Testing)

Model: NOx = A + B · BioPct

(Note: Dataset does not yet include the data on B5.)

Bright yellow highlight indicates result is statistically significant at 95% confidence level or better.
Light yellow highlight indicates result is statistically significant at the 90% confidence level or better.

Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	% Change	Pct Change
Soy-based							
	UDDS	0.997	5.896	0.0100	0.001	0.8%	1.7%
	FTP	0.995	2.024	0.0052	0.003	1.3%	2.6%
	40 mph	1.000	2.030	0.0037	<0.0001	0.9%	1.8%
	50 mph	0.969	1.733	0.0028	0.016	0.8%	1.6%
Animal-based							
	UDDS	0.847	5.911	0.0021	0.080	0.2%	0.4%
	FTP	0.981	2.067	0.0031	0.001	0.7%	1.4%
	50 mph	0.887	1.768	0.0011	0.058	0.3%	0.6%

Turning to the importance of the magnitude of the NOx increases, the South Coast Air Quality Management District (SCAQMD) Final 2012 Air Quality Management Plan estimates 2014 NOx emissions from on-road and non-road diesel vehicles to be approximately 190 tons per day.[4] This means that the approximately 1% increase in NOx emissions due to B5 blends translates to an increase of about 2 tons per day in NOx emissions in the South Coast Air Basin alone, while an approximately 2% increase at B10 equals 4 tons per day within that basin. Continuing to B20 the impact would be 8 tons per day. That these are significant increases is clearly evidenced by the fact that both CARB and SCAQMD have adopted numerous emission control measures targeting NOx that have achieved reductions that are similar to or smaller than these values.

Instead of acknowledging emissions testing data CARB itself generated that show increases in NOx emissions associated with B5 and B10 blends, CARB staff instead claims that more research is necessary before it can consider mitigation of B5 impacts: [5]

> *Staff is currently contracting with the University of California at Riverside to develop data to determine whether there are significant adverse air-related impacts from the use of B5 blends sufficient to warrant mitigation in the future.*

ADF B3-108

[4] See Figure 3-9 available at http://www.aqmd.gov/aqmp/2012aqmp/Final-February2013/MainDoc.pdf
[5] See page 4 of CARB's White Paper "Discussion of Conceptual Approach to Regulation of Alternative Diesel Fuels", February 15, 2013 which is available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20130212ADFRegConcept.pdf

This represents an impermissible deferral of analysis and mitigation of significant impacts under CEQA. Moreover, as participants in the process that lead to the adoption of CARB's Low Carbon Fuel Standard (LCFS) regulation in 2009 where CARB adopted indirect land use change (ILUC) values based on preliminary and unsubstantiated modeling results claiming a need to rely on the best available science, Growth Energy finds CARB staff's current position that ignores actual data showing NOx increases from low level biodiesel blends to be unsupported.

ADF B3-108 cont.

2. The Proposed "Significance Threshold" for Biodiesel would Allow Significant Increases in NOx Emissions to Occur in the South Coast and San Joaquin Valley Air Basins Exacerbating Existing Air Quality Problems

In addition to CARB staff's failure to analyze low-level biodiesel blends, the "significance threshold" proposed by CARB staff for biodiesel use in California would allow significant increases in NOx emissions due to biodiesel use to occur in the South Coast and San Joaquin Valley air basins that experience the worst air quality problems in the state.

According to CARB staff's presentation for the September workshop,[6] staff is proposing to evaluate the significance of NOx increases due to biodiesel use on a statewide rather than a regional basis. Given the proposed use of a statewide average biodiesel level and the B10 significance threshold, the potential exists for significant quantities of B20 or even higher levels of biodiesel blends to be used without mitigation in areas of the state with significant air quality problems, such as the South Coast and/or San Joaquin Valley air basins. At this point, even CARB staff acknowledges that use of B20 blends results in significant NOx increases and as noted above based on CARB's own test data B20 use in the South Coast Air Basin could increase NOx emissions by as much as 8 tons per day in 2014.

ADF B3-109

Given the severe air quality problems that exist in the South Coast and San Joaquin Valley air basins, CARB must modify the proposed ADF regulation so that it guarantees that increased NOx emissions related to biodiesel use would not occur in these areas. The reduction of NOx emissions is important, particularly in light of CARB's "Vision for Clean Air,"[7] which demands the elimination of NOx emissions from diesel engines in both air basins as a perquisite for achieving the state's air quality goals.

3. The Proposed Transfer of Credit for Reductions in NOx Emissions Generated by Low NOx Diesel Producers to Offset Increases in NOx Emissions Generated by Biodiesel Producers is Not Equitable

[6] See slide 18 of the staff presentation for the September 5th workshop which is available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20130905ADFWorkshopPresentation.pdf

[7] See http://www.arb.ca.gov/planning/vision/docs/vision_for_clean_air_public_review_draft.pdf

According to CARB staff's presentation at the September workshop,[8] staff is proposing to directly offset increases in NOx emissions resulting from the use of biodiesel with reductions in emissions due to the use of "low NOx" diesel fuels, which are defined by specific properties as shown in the staff presentation for the September 5th workshop.[9] To date, however, we are unaware of any information or explanation from CARB staff as to why producers of low NOx diesel fuels should be forced by CARB regulations to surrender credit for the NOx emission reductions their fuels achieve in order to benefit the producers of biodiesel fuels which increase NOx emissions.

Given that the production of low NOx diesel fuel is not currently mandated by any existing CARB regulation, the resulting emission benefits should be considered "surplus," and could presumably be used to generate Mobile Source Emission Reduction Credits under CARB regulations.[10] Further, the use of such fuels by fleets or distribution of such fuels by fuel providers could potentially be considered to be projects that qualify for incentive funding under the Carl Moyer Program.[11]

ADF B3-110

Instead of forcing producers of low NOx diesel fuels to transfer the credit for the NOx reductions attributable to their products without compensation to producers of biodiesel fuels that increase NOx emissions, CARB should establish a market mechanism to incentivize the production of low NOx fuels and to disincentivize the production of NOx-increasing biodiesel fuels. The most logical approach to accomplish this would seem to be providing NOx reduction credits to producers of low NOx fuels under the LCFS regulation while assigning NOx emission debits to producers of biodiesel and then requiring the latter to purchase and surrender credits sufficient to offset the increases in NOx emissions associated with their products.

4. The Proposed Treatment of Biodiesel and Biodiesel Blends Used in "New Technology Diesel Engines" (NTDEs) is Not Equitable With CARB's Treatment of Other Fuels

In addition to defects with the proposed ADF regulations described above, we are unaware of any published analysis or supporting data that the use of biodiesel at any concentration in NTDE's would not result in increased NOx emissions. The rationale for this treatment appears to be an assumption that the advanced emission control systems found on NTDEs eliminate any impact of fuel composition on emissions of NOx and potentially other pollutants.

ADF B3-111

Our primary concern with this proposal is that CARB staff has not provided any supporting data or analysis. In addition, if NTDEs are truly insensitive to fuel composition impacts, CARB should make changes similar to those proposed by biodiesel for other fuels. More specifically, if CARB staff's assumption that NTDE emissions are not sensitive to fuel composition is in fact correct, it follows that there is no longer any need to use CARB diesel fuel in NTDEs instead of less expensive federal diesel fuels which could be substituted without any adverse emission impacts.

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[8] See slide 19 of the staff presentation for the September 5th workshop which is available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20130905ADFWorkshopPresentation.pdf

[9] See slide 24 of the staff presentation for the September 5th workshop which is available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20130905ADFWorkshopPresentation.pdf

[10] See http://www.arb.ca.gov/msprog/mserc/mserc.htm

[11] See http://www.arb.ca.gov/msprog/moyer/moyer.htm

Clearly, CARB could develop a "significance threshold" for the sale of federal diesel fuel in California similar to that proposed for biodiesel which would achieve this objective while providing the benefit of reduced diesel costs without adverse air quality impacts. Growth Energy therefore encourages CARB staff to revise the ADF to avoid these impacts.

ADF B3-111 cont.

Sincerely,

David Bearden
General Counsel

3_B_ADF_GE Responses (Page 235 – 242)

205. Comment: **ADF B3-108, ADF B3-110, and ADF B3-111**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

206. Comment: **ADF B3-106**
The comment states concerns regarding the B10 threshold.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed are no longer in the 2015 ADF regulation

207. Comment: **ADF B3-107**
The comment discusses the statistics from a recent CARB diesel study and states that the B10 threshold is not appropriate.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed are no longer in the 2015 ADF regulation.

208. Comment: **ADF B3-109**
The comment contends that the proposed significance threshold for biodiesel would allow significant increases in NOx emissions to occur in the South Coast and San Joaquin Valley basins before exacerbating existing air quality conditions.

Agency Response:
The comment is related to the 2013 ADF proposal. The provisions discussed are no longer in the 2015 ADF regulation.

OTHER EXHIBITS

Public Review Draft
June 27, 2012

Vision for Clean Air: A Framework for Air Quality and Climate Planning

This document has been prepared by the staffs of the California Air Resources Board, the South Coast Air Quality Management District and the San Joaquin Valley Unified Air Pollution Control District. Publication does not signify that the contents reflect the views and policies of the Air Resources Board, the South Coast Air Quality Management District or the San Joaquin Valley Unified Air Pollution Control District. This document will be presented as an informational item at a noticed public meeting scheduled for June 28, 2012.

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Appendix: Actions for Development, Demonstration, and Deployment of Needed Advanced Technologies

Executive Summary

As California plans for the future, transformational technologies, cleaner energy, and greater efficiency are expected to provide the foundation for meeting air quality standards and climate goals. California's success in reducing smog has largely relied on technology and fuel advances, and as health-based air quality standards are tightened, the introduction of cleaner technologies must keep pace. More broadly, a transition to zero- and near-zero emission technologies is necessary to meet 2023 and 2032 air quality standards and 2050 climate goals. Many of the same technologies will address both air quality and climate needs. As such, strategies developed for air quality and climate change planning should be coordinated to make the most efficient use of limited resources and the time needed to develop cleaner technologies.

Vision for Clean Air: A Framework for Air Quality and Climate Planning takes a coordinated look at strategies to meet California's multiple air quality and climate goals well into the future. Its quantitative demonstration of the needed technology and energy transformation provides a foundation for future integrated air quality and climate program development. *Vision for Clean Air* focuses on mobile sources and associated energy production. Similar analyses will be necessary for industrial and other emission sources to develop a complete foundation for integrated planning.

Recognizing that the severity of California's air quality problems varies by region, *Vision for Clean Air* examines what is needed to attain air quality standards by the federal deadlines in the areas with the worst air quality -- the South Coast Air Basin and the San Joaquin Valley Air Basin. However, the technologies and strategies identified will pay clean air dividends for all air districts, helping them achieve or maintain federal air quality standards and reduce local air toxics exposure.

Ozone and Climate Planning Horizons

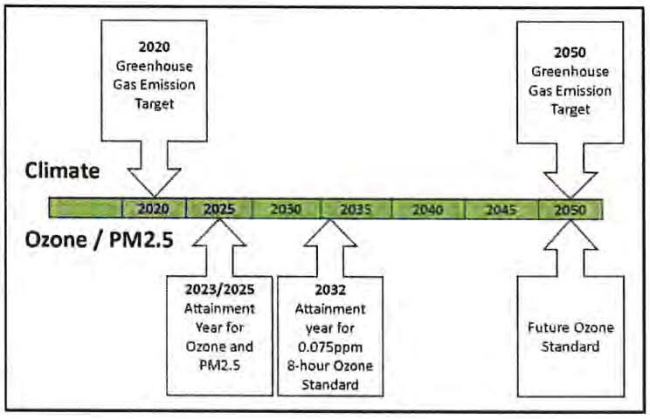


Figure 1

Achieving the 2020 greenhouse gas emission target established by the Global Warming Solutions Act of 2006 (AB 32) is a statewide goal. For the long term, California has set for itself the 2050 goal of greenhouse gas emissions of 80 percent less than 1990 levels overall, and specifically 80 percent less than 1990 levels for the transportation sector.[1] In 2013, the

[1] Governor Brown Executive Order B-16-2012

AB 32 Scoping Plan will be updated to address post-2020 greenhouse gas emissions.

In 2009, the Air Resources Board (ARB), the South Coast Air Quality Management District (SCAQMD) and the San Joaquin Valley Air Pollution Control District (SJVAPCD) developed a partnership with the U.S. Environmental Protection Agency (U.S. EPA) to promote technology advancements needed to meet air quality standards by federal deadlines. In *Vision for Clean Air,* ARB and the South Coast and San Joaquin Valley air districts examine how those technologies can meet both air quality and climate goals over time.

California's deadlines for meeting federal air quality standards extend past 2020, and U.S. EPA recently announced that the deadline for the updated ozone standard will be 2032.[2] Since scientific studies continue to document health impacts of air pollution at progressively lower levels, air quality standards are periodically revised, becoming more stringent over time. Broad deployment of zero- and near-zero emission technologies in the South Coast and San Joaquin Valley air basins will be needed in the 2023 to 2032 timeframe to attain current national health-based air quality standards as required by federal law.

For greenhouse gases, California's 2050 climate goal provides an ambitious long-term target. Many strategies developed to meet the shorter-term air quality standards — notably use of cleaner energy sources — will have benefits toward the longer-term climate goal. Pursuing cleaner energy sources is also the focus of the State's energy policies, providing the opportunity for economic, as well as environmental benefits. Coordinated planning with identified milestones will support the transition to zero-and near-zero emission technologies needed to meet these goals.

To explore the scope of technology advancements needed to meet air quality and climate goals, several key questions are posed:

- What technologies, fuels, and other strategies are needed to meet local air quality and greenhouse gas goals? Are they the same?
- What are the implications of federal air quality deadlines coming 20 to 30 years before the 2050 greenhouse gas goal?
- How can the strategies to meet local air quality targets and greenhouse gas goals best complement each other?
- What are the energy infrastructure demands of coordinated air quality and greenhouse gas strategies?

[2] *Vision for Clean Air* uses 2035 as the target date for the updated ozone standard. After the analytical effort for *Vision for Clean Air* began, U.S. EPA formally set the attainment deadline at 2032.

- How do California's air quality and climate policies need to adapt as emissions move from the vehicle itself to predominantly upstream sources such as electricity and hydrogen or equivalent generation facilities?

Quantitative scenarios were developed for key transportation-related sectors to gain insight into the key questions above. The sectors that are the focus of this report are by far the largest contributors to greenhouse gas emissions and regional air pollution in California. Greenhouse gas emission reduction goals are statewide and the scenarios use a lifecycle emissions analysis approach. The analysis of smog-forming pollutants is regional, reflecting the need to meet air quality standards on that basis. The localized impacts of toxic diesel particulate matter are recognized, and play an important role when evaluating the passenger and freight transport systems. Reducing emissions in these mobile source sectors is key to attaining air quality and climate goals, but does not represent all of the emission reductions needed for individual regions to demonstrate attainment of federal air quality standards. Comprehensive attainment strategies containing both mobile and stationary source measures will be developed as individual regions develop new air quality plans.

The scenarios illustrate the nature of the technology transformation needed to meet the multiple program milestones through 2050. The scenarios highlight the interplay between reducing smog-forming pollutants and greenhouse gases. The scenario results demonstrate the importance of considering the multi-pollutant impacts of policy choices. Planning efforts, public investment, and rulemaking decisions by State, federal, and local agencies will play an important role in the outcome. In making these decisions, agencies will need to consider factors including technical feasibility and cost, downstream and upstream emission reduction potential, energy production capacity and infrastructure, and the necessary pace of transformation needed to meet air quality and climate goals.

In designing the scenarios, it was necessary to make general assumptions about future growth, the pace of introduction of various technologies, and other factors. It is recognized that the scenarios contained herein are not the only pathways to meet air quality and climate goals. Thus, the scenarios are not refined analyses that would be directly used for program development, but will provide input into future planning efforts by air quality agencies. Similarly, economic and environmental analyses are steps that need to be done in future plans.

An update to the AB 32 Scoping Plan is due in 2013. State Implementation Plans (SIPs) to meet the federal particulate matter air quality standards in the South Coast and the San Joaquin Valley are due later this year and major ozone SIPs for the recently updated federal ozone standard will be due in 2015. More detailed analyses will begin to emerge as part of these efforts.

Achieving California's Air Quality and Climate Goals

The federal Clean Air Act requires states to identify the reductions of smog-forming emissions necessary to meet each federal air quality standard. Also under the federal planning process, states must identify the actions needed to bring emissions down to the attainment levels by the required deadlines. These two parts of a state's SIP comprise the attainment demonstration. Federal rules set out detailed procedures, technical requirements, and public processes for the development of attainment demonstrations. As mentioned earlier, the scenarios in *Vision for Clean Air* are not intended to be attainment demonstrations within the meaning of the Clean Air Act, but they do serve to illustrate the scale of technology change needed to meet the federal standards in 2023 and beyond. The federal Clean Air Act specifically recognizes the need for advanced technologies in attainment demonstrations for extreme ozone nonattainment areas. The South Coast and San Joaquin Valley air basins are the only two extreme ozone areas in the nation.

Meeting Federal Ozone Standards

For the South Coast Air Basin, it is estimated that oxides of nitrogen, one of the key ingredients in ozone and fine particulate formation, must be reduced by around 80 percent from 2010 levels by 2023, and almost 90 percent by 2032. Similar levels of emissions reductions are likely needed in the San Joaquin Valley by 2032.

The federally approved SIPs for these two regions rely on a mix of currently available technologies and the development of advanced technologies in order to attain the ozone air quality standard by 2023. Reaching the longer-term 2032 ozone air quality standard and the 2050 climate goal requires even greater transformation. This includes, for example, nearly complete transformation of passenger vehicles to zero-emission technologies, approximately 80 percent of the truck fleet to zero-or near-zero technology, and nearly all locomotives operating in the South Coast air basin to be using some form of zero-emission technology.

Meeting Climate Change Goals

To meet the goal of reducing California's greenhouse gas emissions to 1990 levels by 2050, emissions must be reduced by 85 percent from today's levels.

The Global Warming Solutions Act of 2006 set the 2020 greenhouse gas emissions reduction goal into law. It directed ARB to develop early actions to reduce greenhouse gases while also preparing a Scoping Plan to identify how best to reach the 2020 limit. The State's goal to further reduce greenhouse gases by 2050 was first established when Governor Schwarzenegger signed Executive Order S-3-05 in 2005. In March 2012, Governor Brown issued Executive Order B-16-2012 setting a California target for reductions of greenhouse gas emissions from the transportation sector of 80 percent less than 1990 levels by 2050 and calling for the establishment of benchmarks for the penetration of zero-emission vehicles and infrastructure for 2015, 2020, and 2025.

Coordinated Air Quality and Climate Planning

The *Vision for Clean Air* scenarios illustrate seven key concepts that together provide a foundation for coordinated solutions to California's air quality and climate goals.

- **Technology Transformation:** Transformation to advanced, zero-and near-zero emission technologies, renewable clean fuels, and greater efficiency that can achieve both federal air quality standards and climate goals.

- **Early Action:** Acceleration of the pace of transformation to meet federal air quality standard deadlines, with early actions to develop and deploy zero- and near-zero technologies also needed to meet climate goals.

- **Cleaner Combustion:** Advanced technology NOx emissions standards for on- and off-road heavy-duty engines beyond the cleanest available today to meet federal air quality standards in a timely manner.

- **Multiple Strategies:** A combination of strategies — technology, energy, and efficiency — applied to each sector.

- **Federal Action:** Federal actions, in addition to actions by state and local agencies and governments, to help clean-up sources that travel nationally and internationally such as trucks, ships, locomotives and aircraft.

- **Efficiency Gains:** Greater system and operational efficiencies to mitigate the impacts of growth, especially in high-growth freight transport sectors and vehicle efficiency gains to reduce fuel usage and mitigate the cost of new technologies.

- **Energy Transformation:** Transformation of the upstream energy sector and its greenhouse gas and smog forming emissions concurrent with the transformation to advanced technologies downstream.

Development of coordinated solutions to California's air quality and climate goals will require the efforts of multiple agencies at all levels of government. The solutions span all sectors, rely on the development of multiple technologies, and require the coordinated deployment of technologies and energy infrastructure. ARB has the role of setting technology-forcing standards for mobile sources that have been the distinguishing feature of the State's air quality progress and climate leadership. Action by the federal government, for trucks, locomotives, aircraft, and ships, is also critical. Finally, transformation of the energy sector will require multiple agencies, including the California Energy Commission, the Public Utilities Commission, ARB, and local air districts, to share a common vision.

The SCAQMD, SJVAPCD, and other local air districts play a key role through actions to accelerate the use of new, cleaner mobile technologies at the regional level to improve air quality and meet federal air quality standards. While *Vision for Clean Air* focuses on

the mobile sectors and the energy system to power them, attainment of the federal air quality standards will also require similar transformation of traditional stationary sources covered through SIP planning. Air districts will need to continue their actions to reduce emissions from these sources in order to meet federal requirements. Metropolitan planning organizations, port authorities, and local governments will also play important roles in the overall pollution control strategies.

Private sector activities will be key to developing the technology, building the engines, and implementing the necessary transformation. Engine and vehicle manufacturers will need to continue the development and marketing of advanced technologies. Energy industries will need to supply the renewable fuels and energy, including the necessary infrastructure. In the freight transport industries, increased efficiencies that support growth while mitigating environmental impacts will be essential. Both public and private investment will be needed to enable the technology transformation necessary to achieve California's air quality and climate goals.

Vision for Clean Air lays the foundation for an integrated approach to develop and deploy the cleanest emissions control technologies. For many of the sectors discussed, zero- and near-zero emission technologies have been developed or anticipated to be developed over the next few years. *Vision for Clean Air* provides a timeline for coordinated development and accelerated deployment of the types of technologies expected to be needed in each of the sectors.

Vision for Clean Air is being released as a draft document for discussion at a public meeting in June 2012 and at public workshops in August. The document sets the stage for subsequent planning efforts through scenarios designed to illustrate the scope of change needed to meet federal air quality standards and California's climate goals. The scenarios presented are not intended to identify a specific course of action to meet each air quality and climate goal. Nor are the scenarios a prediction of the actual mix of vehicle technologies, fuels, and clean energy sources expected to emerge in the long term. Public and private investment, regulatory decisions, and consumer preferences will all affect the success of specific strategies and options to meet these ambitious goals.

An Approach for Integrating Air Quality and Climate Planning

The federally approved 2007 State Implementation Plans for the South Coast Air Basin and the San Joaquin Valley Air Basin call for broad use of advanced technologies, clean energy, and greater efficiencies to provide the foundation for meeting federal air quality standards. The 2008 Scoping Plan, required by California's Global Warming Solutions Act of 2006, similarly called for a statewide transition to clean energy and advanced technologies and outlined actions toward that end. To understand the interplay among strategies to meet air quality and climate goals, and to develop common and effective solutions to both, basic questions need to be answered. These include:

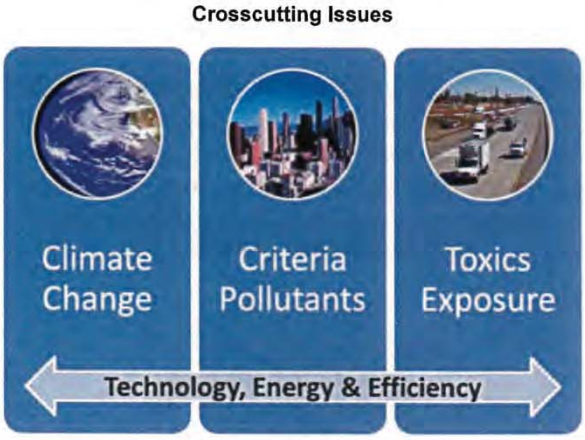


Figure 2

- What technologies, fuels, and other strategies are needed to meet local air quality and greenhouse gas goals? Are they the same?
- What are the implications of federal air quality deadlines coming 20 to 30 years before the 2050 greenhouse gas goal?
- Is the pace of needed transformation the same? How can the strategies to meet air quality targets and greenhouse gas goals best complement each other?
- What are the energy infrastructure demands of coordinated air quality and greenhouse gas strategies?
- How do California's air quality and climate policies need to adapt as emissions move from the vehicle itself to predominantly upstream sources such as electricity and hydrogen generation facilities?

To begin to answer these questions and lay a foundation for future coordinated planning for criteria pollutants regulated through air quality standards (i.e., criteria pollutants), toxic pollutants such as diesel particulate matter, and greenhouse gases, *Vision for Clean Air* uses quantitative scenarios. These scenarios examine the nature of the technology and fuel transformation needed to meet the multiple air quality and greenhouse gas milestones between now and 2050.

Vision Scenarios

Under the Clean Air Act, traditional air quality planning typically focuses on the emissions reductions expected in a single future year from regulations adopted in the

immediate three to five years. *Vision for Clean Air* takes a broader approach and uses scenarios to illustrate the change needed in multiple milestone years to meet future emissions targets. This effort is not a plan, but rather, it provides valuable insight for future planning efforts that will include a stakeholder input process. This long-term approach is more common in greenhouse gas analyses. The advantage of long-term planning is that it reveals the scope of advanced technologies needed, how quickly the technologies need to come on line, and the key decision points for technology development and deployment along the way.

A scenario is a combination of technology, energy, and efficiency assumptions that change over time. Scenarios represent a projection of what could be possible — a ~~-~~what if" story that provides context for decision-making. Scenarios are intended to inform decision-making but are not predictions of what the future will be. So rather than being a list of State Implementation Plan or SIP-ready control measures, the scenarios provide a view of a mix of technologies that could be successful in helping California meet its multi-pollutant goals. Further, the scenarios do not represent a policy choice that favors certain technologies and fuels over others. This scenario planning effort does not identify winners or losers on a specific path to meet air quality and climate goals. Rather, it demonstrates a combination of technologies and fuels that yield the scale of needed transformation. Any other mix of technologies and fuels achieving equivalent or better regional criteria pollutant and life cycle greenhouse gas reductions can be considered part of the scenario.

A Scenario is a "What If" Set of Assumptions about Technologies, Fuels and Efficiencies

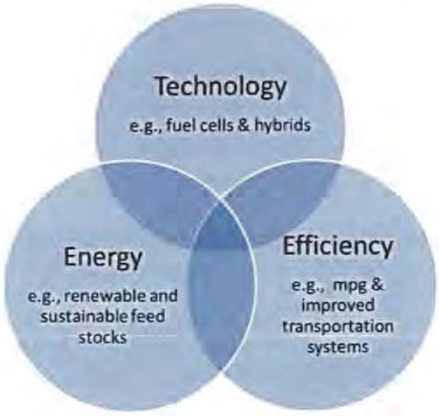


Figure 3

Scenarios were developed through an iterative process of assuming varying levels of technology sales penetration, fuel supply, and efficiency changes. These are ambitious assumptions going beyond the existing programs, and could be expected to require further actions, such as innovation, investment, incentives, and regulations to achieve. However, the scenarios do not include actions such as further incentive funding to accelerate penetration of advanced technologies and clean fuels to meet federal

Scenarios for Mobile Sectors

Scenarios have been developed for passenger cars; freight transport, including trucks, ships, locomotives, cargo handling equipment, and harbor craft; planes, and off-road equipment. The scenarios also include the refineries and power plants needed to produce the fuels and electricity to power the engines in these devices. Together, this covers approximately 45 percent of the State's greenhouse gas emissions and approximately 85 percent of its NOx emissions. The remainder of the greenhouse gas emissions are from non-transportation related sources such as industrial, power generation, commercial, residential and agricultural uses.

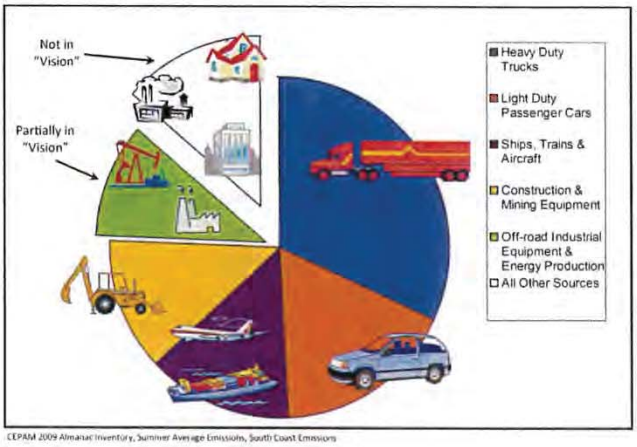
air quality deadlines. For example, expedited turnover of vehicles, as has been achieved with incentives programs implemented by State and local jurisdictions, is not assumed in the scenarios. All of the scenarios include as the starting point all technology and fuel regulations in place today, including passenger vehicle standards, truck and engine standards, the low carbon fuel standard, and the 33 percent renewable electricity requirement.

Most of the technologies and energy sources relied on in the scenarios exist in some form today; some technologies are already on the market, while others are still maturing through demonstration programs and limited test markets.[3] As a result, *Vision for Clean Air* focuses on the development and deployment of emerging technologies not the invention of undefined future technologies. The available technologies that provide fewer smog-forming and greenhouse gas emissions are fuel cells, electric hybrids with a large portion operating in an —all electric range", and electric vehicles, a combination of which is assumed to be the future norm over time. Similarly, alternative fuels such as hydrogen and clean biofuels such as cellulosic ethanol and biomethane and other renewable energy sources are assumed to play an important role in the energy sectors. Additional operational efficiencies to reduce vehicle miles traveled and overall energy demand are also assumed to occur.

Vision Targets

Targets are characterized as the percent reduction needed from today's emission levels in order to meet the federal air quality standards for ozone and the State's long-term goal to reduce greenhouse gas emissions to 80 percent below 1990 levels by 2050. New federal air quality standards for particulate matter are also expected in the near future. Legally-binding emission targets to attain federal air quality standards are established through the air quality planning process set out in State and federal law. The attainment targets for the 0.080 ppm ozone standard, with a 2023 attainment date, are set in the State's federally approved ozone plans. Planning for the 0.075 ppm federal standard is just beginning, but the attainment target is 2032 for the

Relationship of Vision Inventory to SIP Inventory
2010 NOx SIP Sources as Portion of Total Inventory



CEPAM 2009 Almanac Inventory, Summer Average Emissions, South Coast Emissions

Figure 4

[3] The single exception is the carbon capture sequestration process that will be necessary if fossil fuels are to remain in the energy mix of the future. This process has been demonstrated in limited cases, but long-term data has yet to be developed.

extreme ozone areas of the South Coast Air Basin and San Joaquin Valley. The targets used here are estimates of what the attainment targets could be past 2023 based on current air quality information. *Vision for Clean Air* focuses on oxides of nitrogen (NOx) emissions as NOx is the most critical pollutant for reducing regional ozone and fine particulate matter.

The SIP air quality targets and the 2050 greenhouse gas goal apply to the total emissions from all sources. In developing future SIPs and climate plans, the full spectrum of emissions sources must be considered. *Vision for Clean Air* focuses on mobile sectors and assumes the same percent reduction must be achieved by each. Future planning efforts will need to look at the tradeoffs among strategies for specific source categories that achieve relatively more or fewer reductions in light of technological, economic, and other factors. The following are the air quality goals used in the scenario development process:

- Achieve the 0.08 ppm 8-hour federal ozone standard by 2023 by reducing NOx emissions by 80 percent from 2010 levels.
- Achieve the 0.075 ppm 8-hour federal ozone standard by 2032 by reducing NOx emissions by 90 percent from 2010 levels.
- Reduce greenhouse gas emissions by 80 percent below 1990 levels by 2050. This is equivalent to 85 percent from today's levels.

This document does not evaluate emission reductions needed to attain a potential new ozone standard (i.e., 0.06 - 0.07 ppm 8-hr standard). As scientific studies are documenting health impacts of air pollution at very low levels, it is expected that further NOx reductions will be needed in the long-term. U.S. EPA is expected to consider adopting an ozone standard lower than 0.075 ppm in 2013. Achieving a future ozone standard in the range EPA is expected to consider could require additional NOx emissions reductions, totaling 95 percent from 2010 levels.

Air Quality Challenges in the South Coast and San Joaquin Valley

California is home to two of the nation's most pressing air quality challenges. The South Coast and the San Joaquin Valley are the only two areas in the country designated as extreme nonattainment for the federal ozone standard. These same two areas also experience high levels of fine particulate matter. Because of the severity of the air quality changes in these two areas, they determine the transformational change needed to meet federal air quality standards throughout the State. Still, while they face a similar air quality challenge, they are different in terms of the nature of their emission sources.

South Coast Air Basin

The 2007 SIP for the federal ozone standard contains commitments for emission reductions from mobile sources that rely on advancement of technologies, as authorized under Section 182(e)(5) of the federal Clean Air Act. These measures, which have come to be known as the —Blak Box," account for a substantial portion of the NOx emission reductions needed to attain the federal ozone standards — over 200 tons/day. Attaining these standards will require reductions in emissions of nitrogen oxides (NOx) well beyond reductions resulting from current rules, programs, and commercially-available technologies.

Mobile sources emit over 80 percent of regional NOx and therefore must be the largest part of the solution. For the South Coast, the top NOx emission sources projected in 2023 are shown in Figure 5. On-road truck categories are projected to comprise the single largest contributor to regional NOx in 2023. Other equipment involved in goods movement, such as marine vessels, locomotives and aircraft, are also substantial NOx sources.

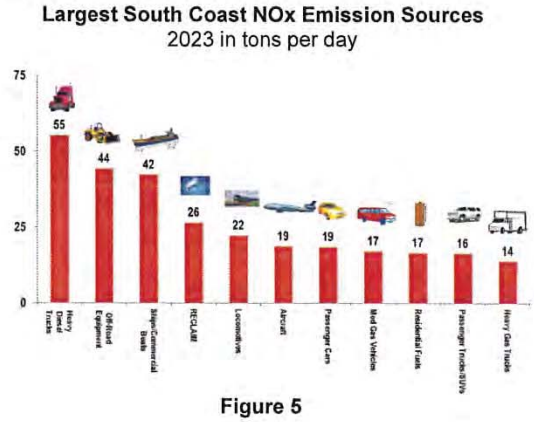


Figure 5

Preliminary projections indicate that the region must reduce regional NOx emissions by about two-thirds by 2023 beyond the benefits of adopted rules and programs, and three quarters by 2032, to attain the national ozone standards as required by federal law.

Since most of the significant sources are already controlled by over 90 percent, attainment of the ozone standards in the South Coast Air Basin will require broad deployment of zero- and near-zero emission technologies in the 2023 to 2032 timeframe. On-land transportation sources such as trucks, locomotives, and cargo handling equipment have technological potential to achieve zero- and near-zero emission levels. Current and potential technologies include hybrid-electric, battery-electric, and hydrogen fuel cell on-road vehicle technologies. Other technologies and fuels may also serve regional

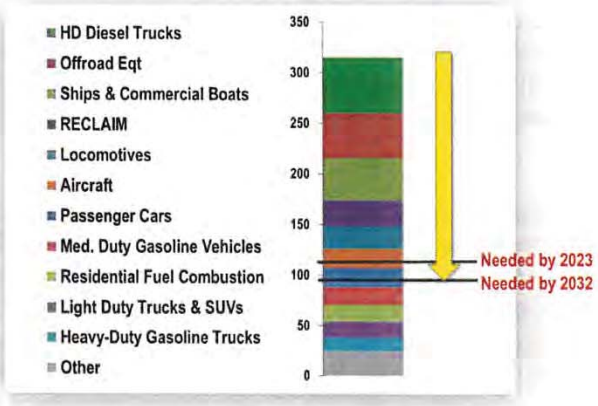


Figure 6

needs, e.g. natural gas-electric hybrids or alternative fuels coupled with advanced aftertreatment technologies. Air quality regulatory agencies have historically set policies and requirements that are performance based and allow any technologies that will achieve needed emission reductions on time.

While there has been much progress in developing and deploying transportation technologies with zero- and near-zero emissions (particularly for light-duty vehicles and passenger transit), additional technology development, demonstration, and commercialization will be required prior to broad deployment in freight and other applications.

San Joaquin Valley Air Basin

Diesel trucks are also the single largest source of NOx emissions in the San Joaquin Valley. However, truck traffic in the Valley is dominated by interstate trucks and other through traffic traveling on the major north-south corridors of Interstate 5 and State Route 99. In contrast, a significant amount of South Coast truck traffic is associated with freight transport from the ports and inland. As a result, the age and activity of the trucks in the two regions differ, suggesting that there may be different options and constraints in terms of technology transformation for trucks that operate in the Valley.

Passenger vehicles are the second largest source of NOx emissions in the San Joaquin Valley. The Valley may present different challenges in terms of infrastructure to support advanced technology passenger vehicles given the nature of urban development in the region.

With the most productive agricultural region in the nation, the San Joaquin Valley is also home to the unique emissions sources of the agricultural industry. While mobile agricultural equipment emissions are significant, a separate scenario was not developed for these sources. Efforts are underway now to clean up mobile agricultural equipment to the cleanest currently available conventional technology. Emission reductions from those efforts are important for reducing ozone levels and measures to achieve these reductions are part of the region's ozone SIP. Given the challenges posed by the operational requirements of this type of equipment and the importance of continuing the current cleanup efforts, consideration of potential future technologies is not included here.

The current NOx targets are set in the approved ozone SIP for the San Joaquin Valley. Like the South Coast, the San Joaquin Valley SIP includes longer-term (—BlackBox") emission reductions due by 2023. Because emissions in the South Coast are so large compared to the Valley, the absolute magnitude of the reductions needed is less than in the South Coast. Nevertheless, the scale of needed transformation is similar. Air quality modeling for the San Joaquin Valley to determine what emission reductions are needed to attain the 0.075 ppm ozone standard in 2032 will be done for the SIP due in 2015. Given the stringent level of the standard, it is expected that on a percentage

basis the San Joaquin Valley and South Coast will need a similar magnitude of new reductions.

Vision Tool

A spreadsheet-based tool developed from the Argonne National Laboratory Vision 2011 Model was used to evaluate the scenarios. The Argonne model was intended to be used to evaluate transportation energy policy questions in the context of greenhouse gas emissions. The *Vision for Clean Air* effort started with the Argonne model and was heavily modified and expanded, such that the tool used for *Vision for Clean Air* is fundamentally a different model.

The basic steps outlined in Figure 7 forecast penetration of vehicle technology and fuels into passenger car and truck fleets based on vehicle stock turnover rates, the rates at which new vehicles and technologies enter the fleet and old vehicles leave. The Argonne model is limited in that it only models greenhouse gases and only for passenger vehicles and trucks based on national fleet characteristics. The tool used for *Vision for Clean Air* adds forecasting capability for smog-forming pollutants (NOx and reactive organic gases) and diesel particles. It is also a California-specific model using new vehicle sales, vehicle miles traveled, vehicle survival rates, and emission rates from ARB's mobile source emissions model, EMFAC. Finally, non-road mobile sources, off-road equipment, locomotives, ships, harbor craft, and cargo handling equipment are included based on ARB's existing emissions inventory models for these sources.

Vision for Clean Air Modeling Structure

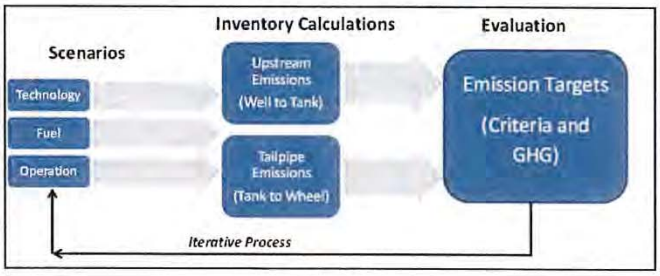


Figure 7

Fuel and electricity demand are estimated by type based on the fleet technology mix, vehicle miles traveled, and engine efficiencies. Emissions from energy production activities are then calculated using assumptions about fuel feedstock, carbon intensity, and NOx emission rates. Carbon emissions are calculated with a global lifecycle from energy production to end use. Smog-forming emissions use a modified life-cycle approach where upstream, fuel pathway emissions are included only if they are within the region studied in the scenario. For simplicity, it was assumed that one half of the NOx emissions from mobile source-related energy production occur within the region in which the energy is used.

This modified lifecycle approach for analyzing smog-forming emissions associated with mobile-source energy production differs from typical air quality planning. In SIPs, mobile and stationary source emissions (including refineries and power plants) are calculated and reported separately. The advantage to linking upstream and

3_B_ADF_GE Responses (Page 243 – 258)

209. Comment: **Vision for Clean Air: A Framework for Air Quality and Climate Planning June 27, 2012 (Partial Reproduction)**

Agency Response:
This document is a collaborative report between ARB, SCAQMD, and SJVAPCD. Only the first 13 pages were submitted. It does not constitute an objection or suggestion on the proposal; however the document was referenced in comment **ADF B3-109**. The response to this comment is in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

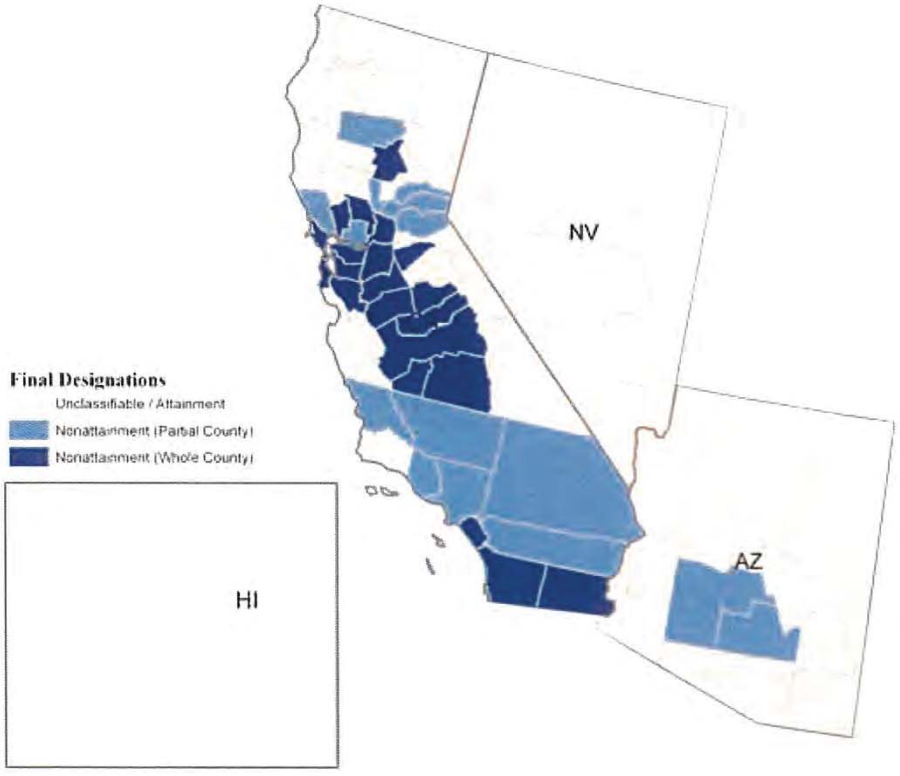
Area Designations for 2008 Ground-level Ozone Standards

2008 Ground-level Ozone Standards — Region 9 Final Designations, April 2012

EPA is implementing the 2008 ozone standards as required by the Clean Air Act. Meeting these standards will provide important public and environmental health benefits. EPA has worked closely with states and tribes to identify areas in the country that meet the standards and those that need to take steps to reduce ozone pollution.

EPAs final designations are based on air quality monitoring data, recommendations submitted by the states and tribes, and other technical information. EPA will work closely with states and tribes to implement the standards using a common sense approach that improves air quality, maximizes flexibilities and minimizes burden on state and local governments.

Map of Final Designations - EPA Region 9



This table identifies area designations for EPAs region 9 states. In some cases EPA designated partial counties. These are identified by a (P). If a county is not listed below, EPA has designated it as unclassifiable/attainment.

EPA Areas for Designations for the 2008 Ozone Standards

State	Area Name	Counties	Area Classification
American Samoa	Entire territory is unclassifiable/attainment		
Arizona	Phoenix-Mesa, AZ	Maricopa (p)	Marginal
		Pinal (p)	
	Rest of state is unclassifiable/attainment		
California	Calaveras County, CA	Calaveras	Marginal
	Chico (Butte County), CA	Butte	Marginal
	Imperial County, CA	Imperial	Marginal
	Kern County (Eastern Kern), CA	Kern (p)	Marginal
	Los Angeles-San Bernardino Counties (West Mojave Desert), CA	Los Angeles (p)	Severe
		San Bernardino (p)	
	Los Angeles-South Coast Air Basin, CA	Los Angeles (p)	Extreme
		Orange	
		Riverside (p)	
		San Bernardino (p)	
	Mariposa County, CA	Mariposa	Marginal
	Nevada County (Western part), CA	Nevada (p)	Marginal
	Riverside County (Coachella Valley), CA	Riverside (p)	Severe
	Sacramento Metro, CA	El Dorado (p)	Severe
		Placer (p)	
		Sacramento	
		Solano (p)	
		Sutter (p)	
		Yolo	
	San Diego County, CA	San Diego	Marginal
	San Francisco Bay Area, CA	Alameda	Marginal
		Contra Costa	
		Marin	
		Napa	
		San Francisco	
		San Mateo	

State	Area Name	Counties	Area Classification
		Santa Clara	
		Solano (p)	
		Sonoma (p)	
	San Joaquin Valley, CA	Fresno	Extreme
		Kern (p)	
		Kings	
		Madera	
		Merced	
		San Joaquin	
		Stanislaus	
		Tulare	
	San Luis Obispo (Eastern San Luis Obispo), CA	San Luis Obispo (p)	Marginal
	Tuscan Buttes, CA	Tehama (p)	Marginal
	Ventura County, CA	Ventura (p)	Serious
	Morongo Areas of Indian Country (Morongo Band of Mission Indians)	Areas of Indian Country	Serious
	Pechanga Areas of Indian Country (Pechanga Band of Luiseno Mission Indians of the Pechanga Reservation)	Areas of Indian Country	Moderate
	Rest of state is unclassifiable/attainment		
Guam	Entire territory is unclassifiable/attainment		
Hawaii	Entire state is unclassifiable/attainment		
Nevada	Entire state is unclassifiable/attainment		
Northern Mariana Islands	Entire territory is unclassifiable/attainment		

< Back to US map

Tribal information is available on the Tribal Designations page.

Recommendations from Region 9 States and EPA Responses

Last updated on Friday, February 01, 2013

3_B_ADF_GE Responses (Page 259 – 261)

210. Comment: **2008 Ground-level Ozone Standards - Region 9 Final Designations, April 2012**

Agency Response:
This document appears to be a printout from EPA's website. It does not constitute an objection or suggestion on the proposal; however the document was referenced in comment **ADF B3-109**. The response to this comment is in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

South Coast
Air Quality Management District
21865 Copley Drive, Diamond Bar, CA 91765-4182
(909) 396-2000 ≠ www.aqmd.gov

SCAQMD Air Quality Significance Thresholds

Mass Daily Thresholds [a]		
Pollutant	**Construction [b]**	**Operation [c]**
NOx	100 lbs/day	55 lbs/day
VOC	75 lbs/day	55 lbs/day
PM10	150 lbs/day	150 lbs/day
PM2.5	55 lbs/day	55 lbs/day
SOx	150 lbs/day	150 lbs/day
CO	550 lbs/day	550 lbs/day
Lead	3 lbs/day	3 lbs/day
Toxic Air Contaminants (TACs), Odor, and GHG Thresholds		
TACs (including carcinogens and non-carcinogens)	Maximum Incremental Cancer Risk ≥ 10 in 1 million Cancer Burden > 0.5 excess cancer cases (in areas ≥ 1 in 1 million) Chronic & Acute Hazard Index ≥ 1.0 (project increment)	
Odor	Project creates an odor nuisance pursuant to SCAQMD Rule 402	
GHG	10,000 MT/yr CO2eq for industrial facilities	
Ambient Air Quality Standards for Criteria Pollutants [d]		
NO2 1-hour average annual arithmetic mean	SCAQMD is in attainment; project is significant if it causes or contributes to an exceedance of the following attainment standards: 0.18 ppm (state) 0.03 ppm (state) and 0.0534 ppm (federal)	
PM10 24-hour average annual average	10.4 $\mu g/m^3$ (construction)[e] & 2.5 $\mu g/m^3$ (operation) 1.0 $\mu g/m^3$	
PM2.5 24-hour average	10.4 $\mu g/m^3$ (construction)[e] & 2.5 $\mu g/m^3$ (operation)	
SO2 1-hour average 24-hour average	0.25 ppm (state) & 0.075 ppm (federal – 99th percentile) 0.04 ppm (state)	
Sulfate 24-hour average	25 $\mu g/m^3$ (state)	
CO 1-hour average 8-hour average	SCAQMD is in attainment; project is significant if it causes or contributes to an exceedance of the following attainment standards: 20 ppm (state) and 35 ppm (federal) 9.0 ppm (state/federal)	
Lead 30-day Average Rolling 3-month average Quarterly average	1.5 $\mu g/m^3$ (state) 0.15 $\mu g/m^3$ (federal) 1.5 $\mu g/m^3$ (federal)	

[a] Source: SCAQMD CEQA Handbook (SCAQMD, 1993)
[b] Construction thresholds apply to both the South Coast Air Basin and Coachella Valley (Salton Sea and Mojave Desert Air Basins).
[c] For Coachella Valley, the mass daily thresholds for operation are the same as the construction thresholds.
[d] Ambient air quality thresholds for criteria pollutants based on SCAQMD Rule 1303, Table A-2 unless otherwise stated.
[e] Ambient air quality threshold based on SCAQMD Rule 403.

KEY: lbs/day = pounds per day ppm = parts per million $\mu g/m^3$ = microgram per cubic meter ≥ = greater than or equal to
MT/yr CO2eq = metric tons per year of CO2 equivalents > = greater than

Revision: March 2011

3_B_ADF_GE Responses (Page 262)

211. Comment: **SCAQMD Air Quality Significance Thresholds**

Agency Response:
This document does not constitute an objection or suggestion on the proposal; however the document was referenced in comment **ADF B3-108**. The response to this comment is in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

GUIDE FOR ASSESSING AND MITIGATING AIR QUALITY IMPACTS

Prepared by
the Mobile Source/CEQA Section
of the Planning Division
of the San Joaquin Valley Air Pollution Control District
1990 E. Gettysburg Avenue
Fresno, CA 93726

January 10, 2002 revision
Adopted August 20, 1998

This document is an advisory document, that provides Lead Agencies, consultants, and project applicants with uniform procedures for addressing air quality in environmental documents. Copies and updates are available from the SJVAPCD Planning Division at (559) 230-5800. Questions on content should be addressed to either the Mobile Source/ CEQA Section at (559) 230-5800 or the SJVAPCD CEQA representative at the regional office that covers the county in which the project is located.

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ACKNOWLEDGEMENTS

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GUIDE FOR ASSESSING AND MITIGATING AIR QUALITY IMPACTS

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Demolition Asbestos Impacts. Project construction sometimes requires the demolition of existing buildings at the project site. Buildings often include materials containing asbestos. Airborne asbestos fibers pose a serious health threat if adequate control techniques are not carried out when the material is disturbed. The demolition, renovation, or removal of asbestos-containing materials is subject to the limitations of the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations as listed in the Code of Federal Regulations[34] requiring notification and inspection. Most demolitions and many renovations are subject to an asbestos inspection prior to start of activity. The SJVAPCD's Compliance Division in the appropriate region should be consulted prior to commencing any demolition or renovation of any building to determine inspection and compliance requirements. Strict compliance with existing asbestos regulations will normally prevent asbestos from being considered a significant adverse impact.

4.3.2 Thresholds of Significance for Impacts from Project Operations

The term "project operations" refers to the full range of activities that can or may generate pollutant emissions when the development is functioning in its intended use. For projects such as office parks, shopping centers, residential subdivisions, and other indirect sources, motor vehicles traveling to and from the projects represent the primary source of air pollutant emissions. For industrial projects and some commercial projects, equipment operation and manufacturing processes can be of greatest concern from an emissions standpoint. Significance thresholds discussed below address the impacts of these emission sources on local and regional air quality. Thresholds are also provided for other potential impacts related to project operations, such as odors and toxic air contaminants.

(Lead Agencies may refer to Section 5, for guidance on calculating emissions and determining whether significance thresholds for project operations may be exceeded, and thus whether more detailed air quality analysis may be needed.)

Ozone Precursor Emissions Threshold. Ozone precursor emissions from project operations should be compared to the thresholds provided in Table 4-1. Projects that emit ozone precursor air pollutants in excess of the levels in Table 4-1 will be considered to have a significant air quality impact.

Both direct and indirect emissions should be included when determining whether the project exceeds these thresholds. The following total emissions thresholds for air quality have been established by the SJVAPCD for project operations. Projects in the SJVAB with operation-related emissions that exceed these emission thresholds will be considered to have significant air quality impacts.

[34] 40CFR Part 61, Subpart M

Table 4-1
Ozone Precursor Emissions Thresholds
For Project Operations

Pollutant	Tons/yr.
ROG	10
NOx	10

Local Carbon Monoxide Concentrations Threshold. Estimated CO concentrations, as determined by an appropriate model, exceeding the California Ambient Air Quality Standard (CAAQS) of 9 parts per million (ppm) averaged over 8 hours and 20 ppm for 1 hour will be considered a significant impact.

Odor Impacts Threshold. While offensive odors rarely cause any physical harm, they can be very unpleasant, leading to considerable distress among the public and often generating citizen complaints to local governments and the SJVAPCD. Any project with the potential to frequently expose members of the public to objectionable odors will be deemed to have a significant impact. Odor impacts on residential areas and other sensitive receptors, such as hospitals, day-care centers, schools, etc., warrant the closest scrutiny, but consideration should also be given to other land uses where people may congregate, such as recreational facilities, worksites, and commercial areas. Analysis of potential odor impacts should be conducted for the following two situations:

- **Generators** – projects that would potentially generate odorous emissions proposed to locate near existing sensitive receptors or other land uses where people may congregate, *and*

- **Receivers** – residential or other sensitive receptor projects or other projects built for the intent of attracting people locating near existing odor sources.

The SJVAPCD has determined some common types of facilities that have been known to produce odors in the SJV. These are presented in Table 4-2 along with a reasonable distance from the source where the degree of odors could possibly be significant.

A Lead Agency should use Table 4-2 to determine whether the proposed project, either as a generator or a receiver, would result in sensitive receptors being within the distances indicated in Table 4-2. In addition, recognizing that this list of facilities is not meant to be all-inclusive, the Lead Agency should evaluate facilities not included in the table or projects separated by greater distances than indicated in Table 4-2 if warranted by local conditions or special circumstances. If the proposed project would result in sensitive receptors being located closer than the screening level distances indicated in Table 4-2, a more detailed analysis, as described in Section 5, should be conducted.

3_B_ADF_GE Responses (Page 263 – 270)

212. Comment: **Guide for Assessing and Mitigating Air Quality Impacts**

Agency Response:
This document is a partial reproduction a SJVAPCD report. It does not constitute an objection or suggestion on the proposal; however the document was referenced in comment **ADF B3-109**. The response to this comment is in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

ATTACHMENT B

VIA EMAIL

February 18, 2014

sierra research

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Jim Aguila, Manager
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Dear Mr. Aguila:

This letter transmits comments regarding the workshop held on February 13, 2014, concerning the Alternative Diesel Fuels (ADF) regulations proposed by the staff on October 15, 2013. The scope of the comments presented here was constrained by the fact that there were only five calendar days and only two business days provided between the date of the workshop and the February 18th deadline for comments announced by CARB staff at the workshop.

As explained below, the modified ADF regulations discussed at the workshop would allow for the widespread use of biodiesel and biodiesel blends in California without adequately mitigating the resulting increases in emissions of oxides of nitrogen (NOx). The workshop proceedings also confirm concerns expressed during the 45-day comment period for the ADF regulations last year that CARB is not providing adequate and prompt public access to relevant documents and information that are in the agency's possession.

ADF B3-112

Sincerely,

Jim Lyons
Senior Partner

Attachments

ADF Regulation Comments
Submitted by James M. Lyons, Sierra Research
February 18, 2014

1. **CARB Has Not Published the Comments from the South Coast Air Quality Management District That Underlie Staff's Proposed Modifications for Extreme Ozone Non-Attainment Areas.**

In the January 31, 2014 workshop notice,[1] CARB states:

> *During the 45-day public review process, staff received comments and proposed alternatives to the noticed regulation that staff would like to more fully consider and evaluate. Staff will be preparing modifications to the original proposal and make the modifications available for public review during a supplemental 15-day public comment period.*

Furthermore, CARB staff notes on slide 8 of the workshop presentation[2] with respect to "45-day rulemaking comments" that:

> *SCAQMD comment requested additional protections for extreme ozone non-attainment areas (South Coast Air Basin, Jan Joaquin Valley).*

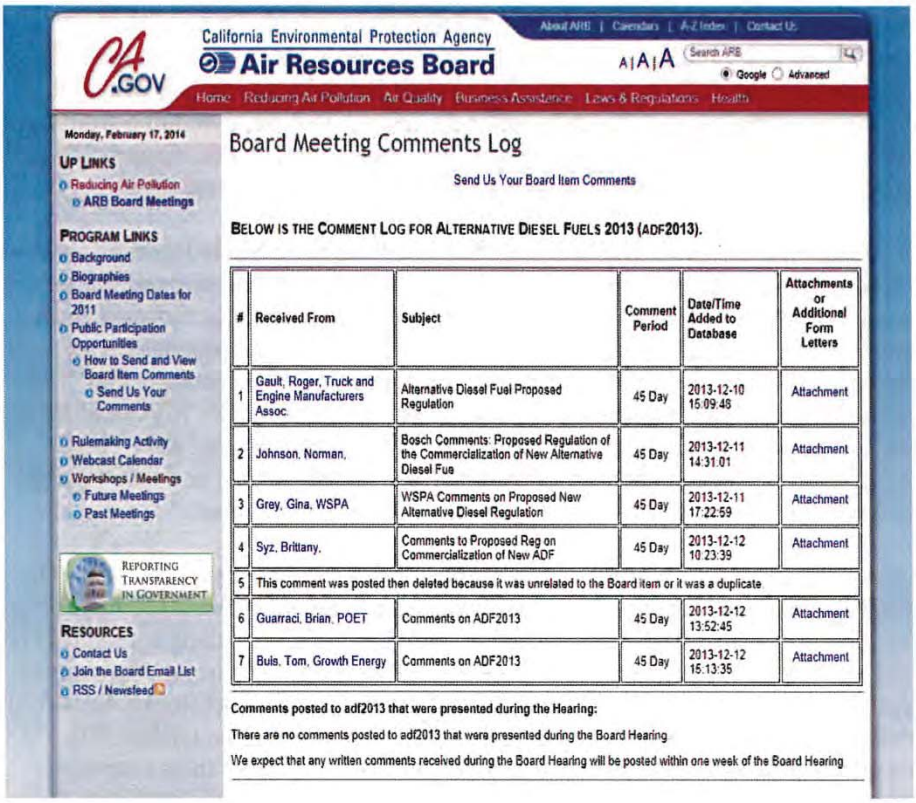
ADF B3-113

However, the relevant comment document from the South Coast Air Quality Management District ("SCAQMD") does not appear as part of the comments submitted during the 45-day comment period posted on the CARB website as shown in the screen shot taken on February 17, 2014, and presented as Figure 1 below. In addition, since there was no public hearing on the proposed regulations held on December 12 or 13, 2013, no comment document could have been provided in that venue.

Because the SCAQMD comments have not been made available to the public, it is impossible for any stakeholder to understand or comment on either the scope of the SCAQMD request or the responsiveness of the modifications proposed by CARB staff at the workshop. CARB staff should make all documents and correspondence related to the SCAQMD comments publicly available and include them in the rulemaking file.

[1] *http://www.arb.ca.gov/fuels/diesel/altdiesel/ADFmtgnotice_021314.pdf*
[2] *http://www.arb.ca.gov/fuels/diesel/altdiesel/021314_PublicMeetingPres.pdf*

Figure 1
Screen Shot From CARB Website on February 17, 2014



California Environmental Protection Agency
Air Resources Board

Home | Reducing Air Pollution | Air Quality | Business Assistance | Laws & Regulations | Health

Monday, February 17, 2014

UP LINKS
- Reducing Air Pollution
- ARB Board Meetings

PROGRAM LINKS
- Background
- Biographies
- Board Meeting Dates for 2011
- Public Participation Opportunities
  - How to Send and View Board Item Comments
    - Send Us Your Comments
- Rulemaking Activity
- Webcast Calendar
- Workshops / Meetings
  - Future Meetings
  - Past Meetings

RESOURCES
- Contact Us
- Join the Board Email List
- RSS / Newsfeed

Board Meeting Comments Log

Send Us Your Board Item Comments

BELOW IS THE COMMENT LOG FOR ALTERNATIVE DIESEL FUELS 2013 (ADF2013).

#	Received From	Subject	Comment Period	Date/Time Added to Database	Attachments or Additional Form Letters
1	Gault, Roger, Truck and Engine Manufacturers Assoc.	Alternative Diesel Fuel Proposed Regulation	45 Day	2013-12-10 15:09:48	Attachment
2	Johnson, Norman,	Bosch Comments: Proposed Regulation of the Commercialization of New Alternative Diesel Fue	45 Day	2013-12-11 14:31:01	Attachment
3	Grey, Gina, WSPA	WSPA Comments on Proposed New Alternative Diesel Regulation	45 Day	2013-12-11 17:22:59	Attachment
4	Syz, Brittany,	Comments to Proposed Reg on Commercialization of New ADF	45 Day	2013-12-12 10:23:39	Attachment
5	This comment was posted then deleted because it was unrelated to the Board item or it was a duplicate				
6	Guarraci, Brian, POET	Comments on ADF2013	45 Day	2013-12-12 13:52:45	Attachment
7	Buis, Tom, Growth Energy	Comments on ADF2013	45 Day	2013-12-12 15:13:35	Attachment

Comments posted to adf2013 that were presented during the Hearing:

There are no comments posted to adf2013 that were presented during the Board Hearing.

We expect that any written comments received during the Board Hearing will be posted within one week of the Board Hearing.

2. CARB Staff Has Failed to Include Results from On-Going CARB-Sponsored Research Regarding the Impacts of Biodiesel on NOx Emissions in the Rulemaking Process.

During last week's workshop, a representative of the SCAQMD commented that increases in NOx emissions due to biodiesel use at levels as low as five percent biodiesel ("B5") remained a concern to his agency based on emission test results from an ongoing CARB-sponsored study being conducted by the University of California, Riverside ("UCR"). The SCAQMD representative stated that the UCR data showed statistically significant increases in NOx emissions for some types of B5 blends compared to conventional diesel fuel. CARB staff's response to this comment was that the study was still "on-going" and that no conclusions can be drawn from the emission testing until the study is completed. In response to questioning, CARB staff indicated that the contract for the project expires in July 2014 and suggested that all work related to the study would be complete by that date. As stakeholders have previously commented, CARB staff must include all available emission data regarding biodiesel impacts on emissions of NOx and other pollutants in the file for this rulemaking.

ADF B3-114

It should be noted that, even if some members of the CARB staff consider the UCR work to be incomplete, other members of the CARB staff evidently consider the UCR data to be complete enough to warrant use in public meetings. Direct evidence supporting the assertion made by the SCAQMD representative at the workshop is provided by a presentation made by Georgios Karavalakis of UCR on April 10, 2013, at the 23rd Coordinating Research Council (CRC) Real World Emission Workshop, which lists among the coauthors two CARB staff members and acknowledges funding from CARB contract No. 10-417. A copy of this presentation and documentation demonstrating that it was presented at the April 2013 workshop is attached to these comments. ADF B3-115

In the section of the presentation labelled "CARB HD Engine Study Results," data are presented from preliminary emissions testing of B5 blends of both soy and waste vegetable oil ("WVO") based biodiesels using procedures similar to those set forth in Appendix A of the Initial Statement of Reasons ("ISOR") for the proposed ADF regulations. Based on these data, the authors conclude in the presentation that "NOx emissions showed slight but statistically significant, increase for B5-WVO and B5-soy blends." The authors conclude with respect to "certification testing" that "NOx emissions showed a statistically significant increase for B5-WVO" and that "The B5-WVO failed the statistical certification test, based on NOx emissions." ADF B3-116

This presentation raises a number of issues that CARB staff must address. First, the presentation provides evidence that directly contradicts the assertion made by CARB staff in the ISOR that there is no evidence of increased NOx emissions at biodiesel levels below B10—an assertion that is the foundation for the CARB environmental impact analysis presented in the ISOR. Second, these data directly support Robert Crawford's conclusions[3] that biodiesel use at levels below B10 will result in increased NOx emissions. Mr. Crawford's work was included by Growth Energy in its comments submitted to CARB staff during the 45-day comment period. Third, given that these data were available at least as early as April 2013, CARB staff should explain why they were not included in the staff's analysis of NOx impacts published in the ISOR nor in the rulemaking file for the ADF regulation. ADF B3-117

Again, CARB staff must include in the rulemaking file for this proceeding all emission test data currently available from this B5 testing program and any other biodiesel testing programs that the agency is sponsoring or otherwise participating in. This is particularly important here as the test data being excluded do not support the staff's assumption in the ISOR that there is no increase in NOx emissions until biodiesel blends reach the B10 level. ADF B3-118

3. The Proposed Modifications to the ADF Regulation Affecting Extreme Ozone Non-Attainment Areas Will Not Prevent Significant Increases in NOx Emissions from Biodiesel Use.

As presented by CARB staff at last week's workshop, the modifications to the proposed ADF regulation that would impose different requirements for extreme ozone non-attainment areas would be limited to the following: ADF B3-119

[3] Crawford, R., "NOx emission Impact of Soy- and Animal-based Biodiesel fuels: A Re-Analysis", December 10, 2013.

1. Establishment of "effective blend" (EB) requirements for biodiesel producers and importers;

2. Requirements for biodiesel producers and importers to submit compliance plans demonstrating how NOx emission increases will be mitigated once their EB level reaches five percent; and

3. Implementation of NOx mitigation measures once their EB level reaches seven and a half percent.

Presumably CARB staff has proposed these changes because they recognize that the originally proposed ADF regulation could lead to unacceptable increases in NOx emissions in the South Coast and San Joaquin Valley Air Basins. Nevertheless, the changes do nothing to ensure that increased NOx emissions due to biodiesel use will not actually occur.

ADF B3-119 cont.

The basic problem with the staff's proposed modifications is their continued reliance on the flawed effective blend (or EB) concept which, as pointed out in comments provided during the 45-day comment period, virtually ensures that the use of biodiesel in California will result in unmitigated increases in NOx emissions. As stakeholders indicated during the 45-day comment period, the only way to ensure that there are no increases in NOx emissions is for CARB staff to abandon the EB concept and to impose appropriate mitigation requirements based on the **actual** biodiesel content of all biodiesel blends. Furthermore, by appropriately mitigating the increases in the NOx emissions associated with biodiesel use, areas like the South Coast and San Joaquin Valley Air Basins will also realize the benefits of any NOx reductions associated with the use of "Low NOx diesel."

4. The Proposed ADF Regulation Should Be Modified to Require Determination and Reporting of the Biodiesel Content of All Biodiesel Blends Prior to Their Sale to Ultimate Consumers.

During last week's workshop, it became clear that the proposed ADF regulation will not ensure that the biodiesel content of blends sold in California will be accurately known or reported to CARB. As indicated by workshop participants, at present CARB has no requirement for determining the biodiesel content of diesel fuels being imported or distributed in the state that contain biodiesel up to the B5 level. Given this, a party interested in blending 5% biodiesel into a "diesel" fuel may be unaware of the fact that the "diesel" fuel could already contain up to 5% biodiesel and that the resulting blend would therefore be B10, not B5. Similarly, a party interested in blending 20% biodiesel into a "diesel" could in fact produce a B25 blend, instead of the intended B20 blend. Obviously, both circumstances have substantial ramifications with respect to potential NOx increases associated with the use of biodiesel in California.

ADF B3-120

Given the above, CARB must modify as necessary its existing diesel fuel regulations as well as the proposed ADF regulations to ensure that the biodiesel content of all blends of

biodiesel and diesel sold in California is accurately known and reported to both CARB as well as the Division of Measurement Standards. This could easily be accomplished by requiring that all "diesel" fuels used in biodiesel blends be tested before blending for Fatty Acid Methyl Ester (FAME) content using appropriate test procedures such as the EN14103:2011 procedure already referenced in the proposed ADF Regulations or the ASTM D7371 procedure. Alternatively, CARB could require testing of final blends for FAME content. Again, failure by CARB to require accurate measurement and reporting of the biodiesel content of biodiesel-diesel blends will lead to unmitigated increases in NOx emissions along with other potential issues, including violations of pump labeling and vehicle manufacturer warranty requirements.

ADF B3-120 cont.

5. CARB Staff Must Publish an Analysis of All Alternatives to the Proposed ADF Regulation Raised During the 45-Day Comment Period.

The "Analysis of Alternatives" presented on pages 62 and 63 of the ISOR states:

> *Specifically for biodiesel, we considered two alternatives to the proposal: business as usual (i.e., no proposed regulation), and requiring implementation of the mitigation measures for all biodiesel blends above B10 immediately without the proposed phase in process.*

ADF B3-121

CARB staff must perform an expanded analysis of alternatives that includes not only the modifications to the original proposal discussed at the workshop but also all alternatives recommended during the 45-day comment period. No such analysis was presented at last week's workshop. Clearly CARB staff should perform this analysis and consider the results, including public comment, before formally proposing modifications to the ADF regulation.

3_B_ADF_GE Responses (Page 271 – 277)

213. Comment: **ADF B3-112 and ADF B3-116**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

214. Comment: **ADF B3-113**
The comment alleges that ARB staff neglected to place all appropriate documentation into the official rulemaking file.

Agency Response:
Please see response **ADF 5-3**.

215. Comment: **ADF B3-114**
The comment contends that ARB staff neglected to make ongoing scientific data available to the public.

Agency Response: The comment is not related to the ADF proposal; rather the comment is a resubmittal of feedback sent to ARB regarding a pre-rulemaking workshop. Staff has made changes to the proposal since the pre-rulemaking workshops and has made every effort to ensure that requested data was made available to the public. Please see response **ADF 17-9**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations." **.**

216. Comment: **ADF B3-115**
The comment states that members of University of California, Riverside (UCR) with co-authors from ARB staff presented scientific findings at the April 2013 workshop as final rather than preliminary.

Agency Response:
The comment is not related to the ADF proposal; rather the comment is a resubmittal of feedback sent to ARB regarding a pre-rulemaking workshop. To the extent that further information will clarify staff's intent, it is clear from the slides in the presentation at the April 2013 workshop (http://www.arb.ca.gov/fuels/diesel/altdiesel/meetings/meetings.htm), that all the conclusions and data presented of the UCR work were considered preliminary and no analysis contained in the presentation implies that the study was entirely complete. Standard practice in science does not demand that preliminary analysis be avoided; only that no final permanent conclusions can be reached until all data and results have been reviewed. In this case, preliminary results were

presented to keep the public apprised of ARB's status and potential findings as a courtesy to our stakeholders. By its nature, preliminary analysis is incomplete and may change.

217. Comment: **ADF B3-117**
The comment summarizes a number of comments from the letter.

Agency Response:
The comment is not related to the ADF proposal; rather the comment is a resubmittal of feedback sent to ARB regarding a pre-rulemaking workshop. The analysis and provisions have been updated in the 2015 ADF regulation. The analysis in the presentation mentioned is discussed in response **ADF B3-115**.

218. Comment: **ADF B3-118**
The comment reminds ARB staff to place all data from biodiesel test programs sponsored by ARB into the rulemaking file.

Agency Response:
Please see response **ADF 17-9** in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

219. Comment: **ADF B3-119**
The comment contends that the use of an Effective Blend level to restrict biodiesel use will not work.

Agency Response:
The comment is not related to the ADF proposal; rather the comment is a resubmittal of feedback sent to ARB regarding a pre-rulemaking workshop. The provisions discussed are no longer in the 2015 ADF regulation

220. Comment: **ADF B3-120**
The comment directs ARB to modify existing diesel regulations to ensure that the biodiesel content of all blends sold in California are accurately known and reported both to CARB and DMS.

Agency Response:
Please see discussion of biodiesel blending in response **ADF 17-8**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

221. Comment: **ADF B3-121**
The comment suggests that not enough alternatives were considered as a part of the 2013 ADF proposal.

Agency Response:
The comment discusses a presentation from a workshop in early 2014 and is not directed at the Staff Report for the 2015 ADF regulation.



BIODIESEL AND RENEWABLE DIESEL CHARACTERIZATION AND TESTING IN MODERN LD DIESEL PASSENGER CARS AND TRUCKS AND HD ENGINES

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Bourns College of Engineering
Center for Environmental Research and Technology (CE-CERT)
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Introduction

- **Potential Sources of Biodiesel**
  - Vegetable oils
    - Edible oils: Soybean oil, rapeseed oil, palm oil, etc.
    - Inedible oils: Jatropha, Camelina, Karanja, etc.
  - Animal Fats
  - Waste Cooking Oils
  - 'Alternative' Oils
    - Algae
- **Benefits**
  - Reduce petroleum dependence
  - Reduce overall life cycle CO_2 emissions
  - Potential improvements in "smog" emissions



Alternative Fuels Legislation

Federal

- Energy Policy Act
  - Renewable Fuels Standard
  - Biofuels Research and Development

California

- Low Carbon Fuel Standard (LCFS)
  - Reduce 10% carbon intensity of California's transport fuels by 2020.
- AB 32 – Global Warming Solutions Act
- Bioenergy Action Plan
- AB 1007 – Alternative Fuels Plan
- AB 118 – Alternative and Renewable Fuel and Vehicle Technology Program



Concerns about using Biodiesel from Emissions Perspective

- Concern about NOx emissions increases with biodiesel
  - Lack of information with vehicles/engines fitted with DPF, SCR, and LNT controls
- A general trend towards higher aldehyde emissions (i.e., formaldehyde, acetaldehyde, acrolein, etc.)
- Biodiesel origin and quality may adversely affect the formation of light molecular-weight PAH emissions
- Characterization of biodiesel exhaust from SCR-fitted vehicles is still incomplete; potential formation of nitrogen-containing compounds (nitro-PAHs)
- Concern about nanoparticle number emission increases with biodiesel



Objectives of the AVFL – 17b Study

- Evaluation of fuel type and quality on exhaust emissions of modern technology light-duty diesel vehicles.
- Assessment of the impact of modern technology aftertreatment control devices on the emissions formation from biodiesel and renewable diesel fueled vehicles.
- Emphasis on gaseous toxic emissions, ammonia, and ultrafine particles.
- Chemical characterization of PM emissions; Concern about EC/OC fractions, PAH, and nitro-PAH compounds some of which are carcinogenic and mutagenic to humans.
- Evaluation of emissions during DPF regeneration events on different fuels; physicochemical characterization of PM.



Test Fuels and Vehicles for the AVFL – 17b Study

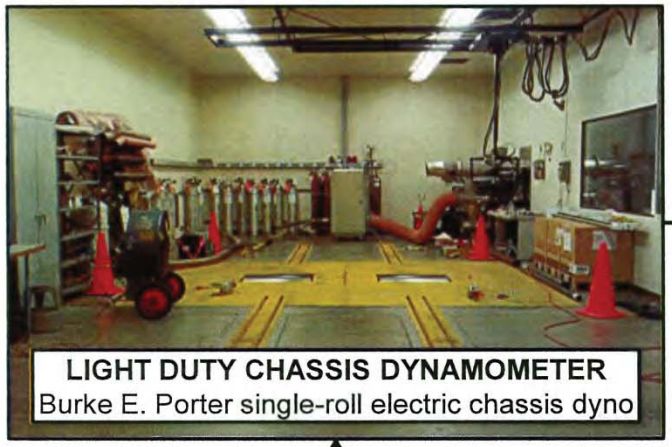
- A total of seven fuels will be used in the study
  - A Federal ULSD and a CARB ULSD, which will serve as baseline fuels
  - Three biodiesels obtained from soy, waste cooking oil, and animal fat
  - A renewable diesel (Hydrogenated Vegetable Oil - HVO)
  - All biodiesels and HVO will be blended with Federal diesel at 20% by volume. CARB diesel will be blended with WCO.
- Currently, we tested a total of 3 vehicles with plans to test 5 additional vehicles.

#	Aftertreatment	MY	Displacement	Configuration
Veh #1	DOC+DPF+SCR	2012	3.0L	V6
Veh #2	DOC+DPF+SCR	2012	6.6L	V8
Veh #3	DOC+DPF+SCR	2012	2.0L	4 cylinders
Veh #4	DOC+DPF+LNT	2012 or 2013	6.7L	6 cylinders
Veh #5	DOC+DPF+SCR	2012/13	6.7L	V8
Veh #6	DOC+DPF+SCR	2012/13	3.0L	V6
Veh #7	DOC+DPF+LNT	2012/13	2.0L	4 cylinders
Veh #8	TBD	2012 or 2013	TBD	TBD

Testing Protocol

- Emissions and fuel economy tests will be performed on the Federal Test Procedure (FTP) driving cycle.
  - Each vehicle/fuel combination will be tested at least twice.
  - A third test will be performed if the differences in FTP regulated emissions exceed a predefined limit: THC 33%, NO_x 29%, CO 70%, provided the absolute difference in the measurements is greater than 5 mg/mi.
- For the oil conditioning protocol, the vehicle will be conditioned on the oil for a period approximately equivalent to two US06 cycles, followed by an LA4 and a US06 cycle sequence repeated twice. This protocol provides more robust preconditioning, especially for improving the repeatability of the nucleation mode particles under hot start/running conditions.

Experimental Setup



LIGHT DUTY CHASSIS DYNAMOMETER
Burke E. Porter single-roll electric chassis dyno



DIESEL VEHICLE

Carbonyls
DNPH sampling
(silica cartidges)

Elemental / Organic
Carbon (Quartz)

Mass (Teflon)

PAHs/nitro-PAHs
(XAD resin/quartz filter)

Filter Samples

Constant Volume Sampling Tunnel
Pierburg Positive Displacement Pump CVS

Real-time NH_3
Tunable Diode Laser

THC, NMHC, NOx, CO, CO_2, FTIR
Pierburg AMA-4000 Bench

Hydroscopicity
Cloud Condensation Nuclei Counter

Mass
Dekati Mass Monitor

Particle Size
TSI Engine Exhaust Particle Sizer
Spectrometer 3090 (5.6 to 560 nm)

Diluter

Particle Size
TSI Scanning Mobility Particle Sizer

Particle Count
TSI 3776 Ultrafine Condensation Particle
Counter (down to 2.3nm)

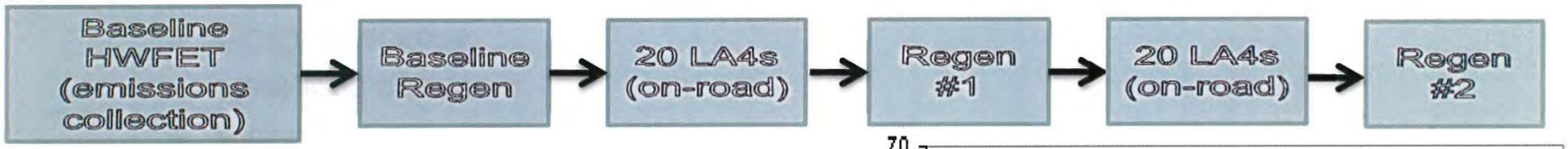
Particle Counts
TSI Condensation Particle
Counter 3772 (down to 10 nm)

Particle Counts
TSI Condensation Particle
Counter 3785 (down to 5 nm)

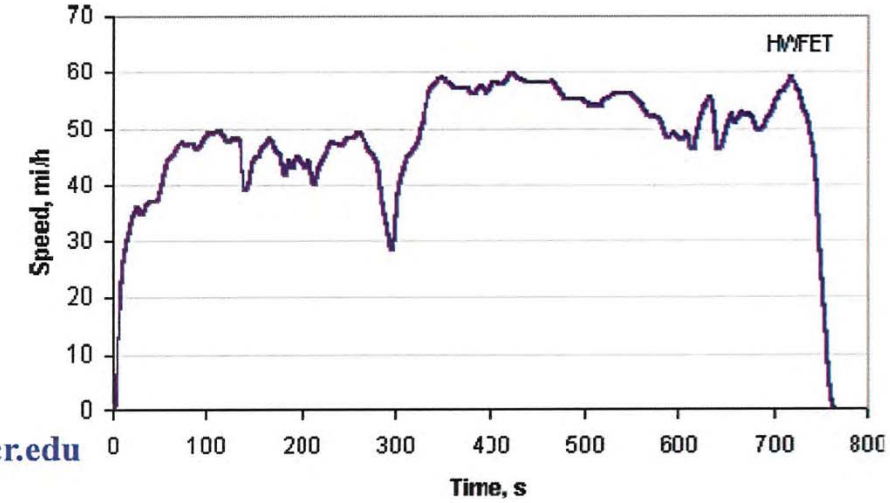
Particle Scattering
Thermo Scientific Multi-Angle Absorption
Photometer (MAAP) 5012

Regeneration Testing Protocol

- A total of two fuels were tested during regeneration testing: Federal ULSD and Fed/SME-20.
- The regeneration testing protocol included driving the vehicle on-road on a route designed to simulate the LA4 portion of the FTP cycle in terms of typical speeds as well as number of stops, for approximately 170 miles (20 LA4s) to build up soot in the DPF.
- Testing was conducted over a double EPA Highway Fuel Economy Cycle (HWFET).



- Regulated emissions, PM mass, particle number emissions and particle size distributions, carbonyls, PAHs/nitro-PAHs, EC/OC, and NH_3 emissions will be measured during a regeneration event for each vehicle/fuel combination.



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Current Status

- Measurements are being made for:
  - Regulated emissions (NOx, PM, THC, CO, CH_4, NMHC, and CO_2) and fuel economy
  - Aldehydes and ketones
  - Real-time ammonia
  - EC/OC fractions
  - Particle number emissions
  - PAHs and nitro-PAHs
- Additional measurements are being made for:
  - Particle size distributions
  - Black carbon
  - Particles solubility
  - Hydroscopicity

Additional Work

- Comprehensive statistical analysis based on a complete data set
- QA/QC

- Future Work:
  - Further study on the emissions from low-environmental impact feedstock biodiesels, such as algae-based fuels
  - A more complete assessment on the emissions performance of high concentration renewable diesel (HVO) blends in modern technology diesel vehicles.
  - More information is needed on the physical, chemical, and biological characterization of particulate emissions during regeneration events from light- and heavy-duty vehicles operated on alternative fuels.



Acknowledgements

- This project is totally funded by the Coordinating Research Council (CRC) under contract No. CRC AVFL – 17b.
- Mr. Kurt Bumiller and Mr. Mark Villela of the University of California, Riverside for their contributions in conducting the emissions testing for this program.
- Thanks for the technical guidance from the CRC AVFL- committee and the AVFL-17b technical panel led by Dr. Mani Natarajan of Marathon Petroleum Company.
- Thanks to Mercedes Benz and Volkswagen for providing the vehicles.
- The Panel Members are: Brent Bailey (CRC), Mani Natarajan (Marathon Petroleum Company), Bill Cannella (Chevron), Dominic DiCicco (Ford), King Eng (Shell), Garry Gunter (Phillips 66), Scott Jorgensen (GM), David Lax (API), Shailesh Lopes (GM), Jenny Sigelko (Volkswagen), Marie Valentine (Toyota), William Woebkenberg (Daimler), Krystal Wrigley (Exxon Mobil)



CARB HD Engine Study Results

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Objectives of the HD Engine Study

- Evaluation and development of NO_x neutral biodiesel formulations
- Certification of one or more biodiesel blends under CARB Alternative Diesel Fuel Formulation Certification Procedure

UCR | College of Engineering- Center for Environmental Research & Technology



Test Fuels

- B5-animal, B5-WVO and B5-soy
- CARB Reference fuel

(title 13, CFR, section 2282(g)(3) fuel specification with nominally 10% aromatic content)

Test Matrix

- Preliminary/scoping testing with B5-animal, B5-WVO and B5-soy
- Full Certification Test with B5-animal and B5-WVO

Testing Details

- 2006 Cummins ISM 370 : In-line, 6 Cylinder, Turbocharged, with EGR
- Federal Testing Procedure (FTP)
- THC, NMHC, CO, NO_x, CO_2, PM, Soluble Organic Fraction (SOF)

Test Sequence

Day	Fuel Test Sequence
1	RC CR RC CR
2	RC CR RC CR
3	RC CR RC CR
4	RC CR RC CR
5	RC CR RC CR

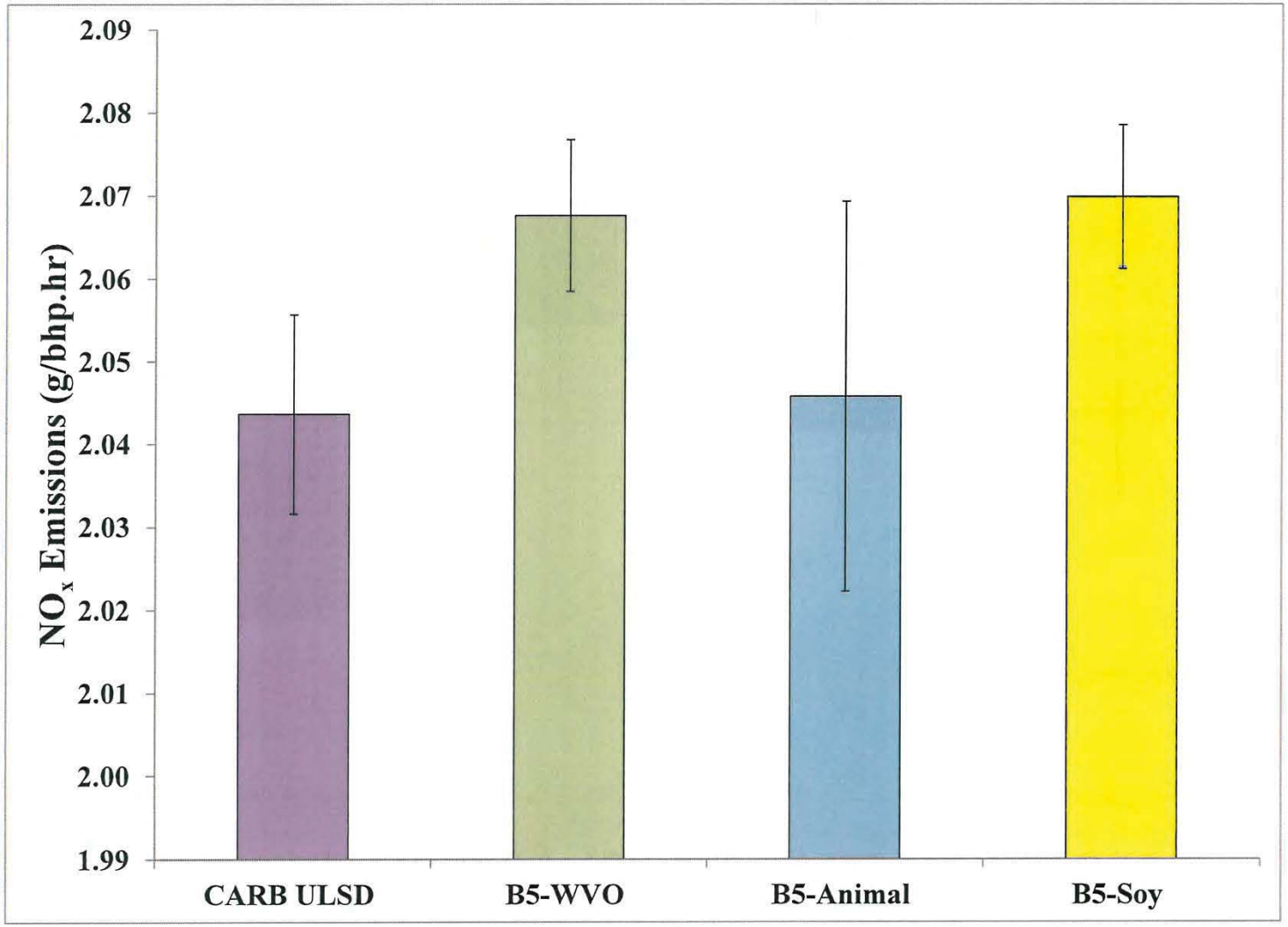




Fuel Properties

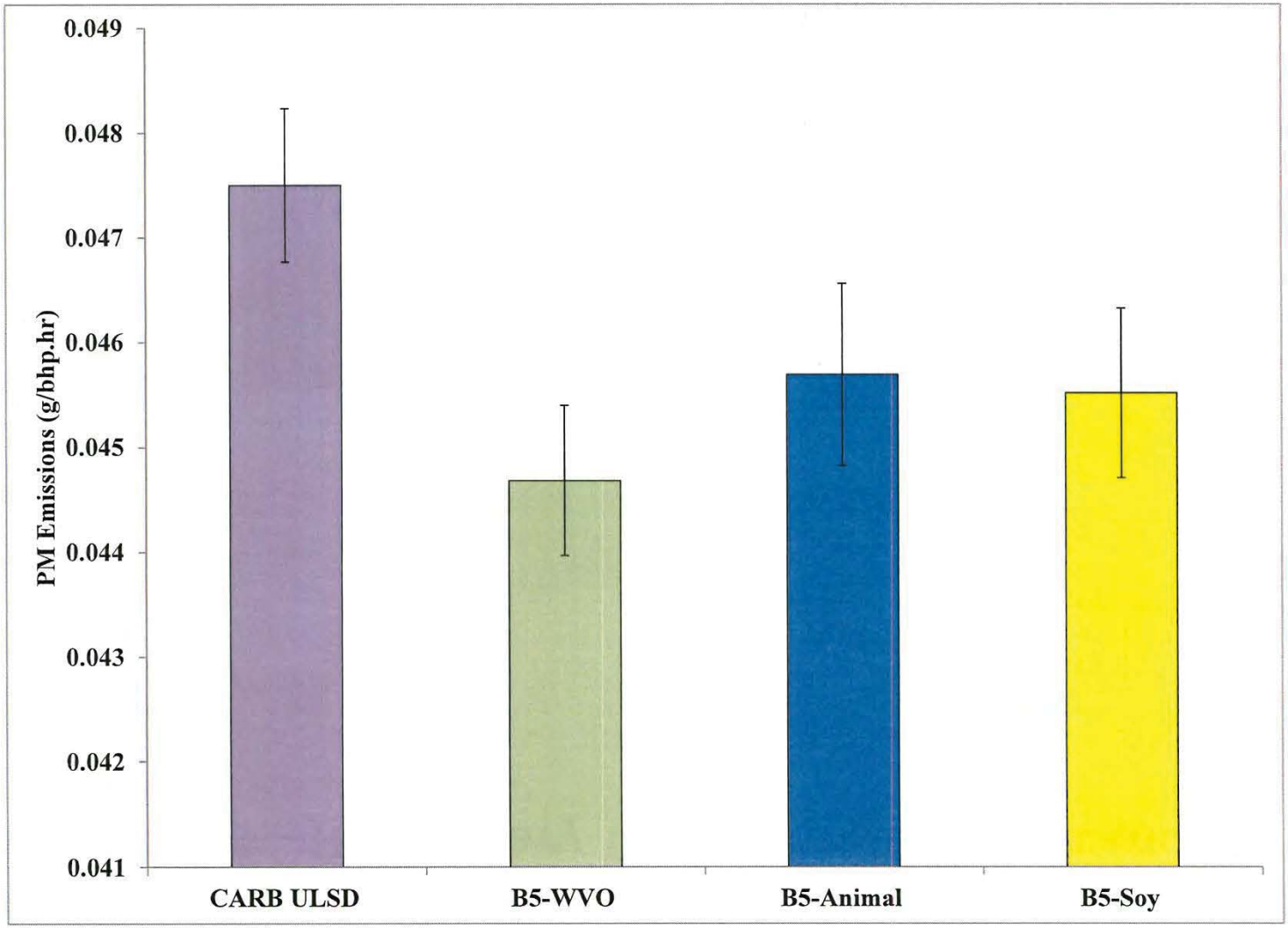
Property	Test Method	Units	CARB	B100-Animal	B100-WVO	B100-Soy	B5-Animal	B5-WVO
Heating value	ASTM D240	BTU/lb	19689	17133	17076	17140	19661	19649
API Gravity@60°F	ASTM D4052			30.20	28.40	28.43	38.5	38.2
Specific Gravity @60°F	ASTM D4052		0.839	0.8750	0.8851	0.8848	0.8326	0.8339
Carbon	ASTM D5291	wt%	85.80	76.19	76.67	77.10	85.78	85.85
Hydrogen	ASTM D5291	wt%	13.61	12.28	11.98	11.85	13.8	13.82
Carbon Unit per Energy		Carbon lbs./BTU	4.36×10^{-5}	4.45×10^{-5}	4.49×10^{-5}	4.50×10^{-5}	4.36×10^{-5}	4.37×10^{-5}
Sulfur		ppm	4.7	6.5	11.1	1.1	4.5	5.3
Cetane number			53.1	61.1	54.6	49.2	61	52.2

NO_x Emissions – Preliminary Testing of B5 Certification

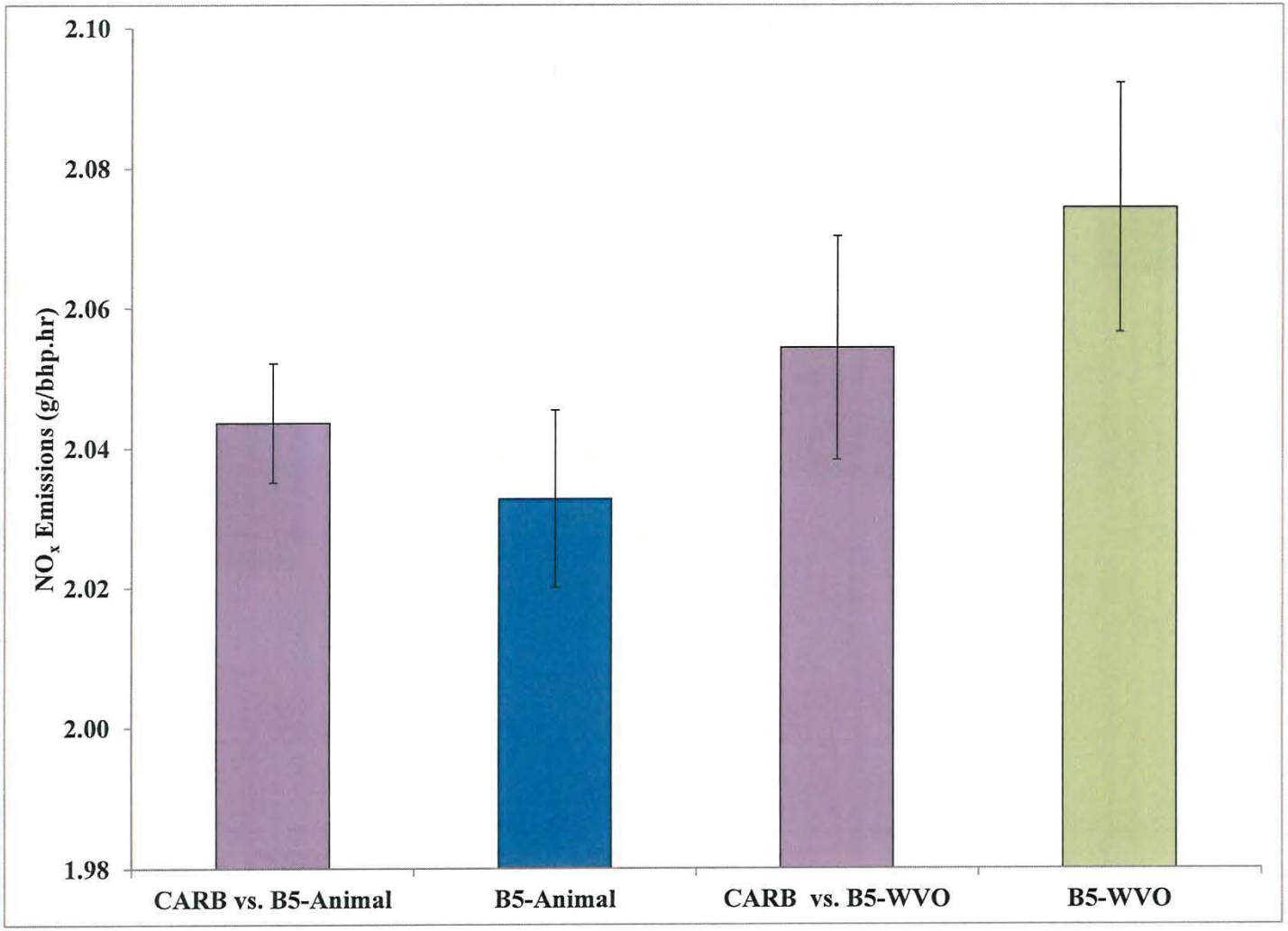


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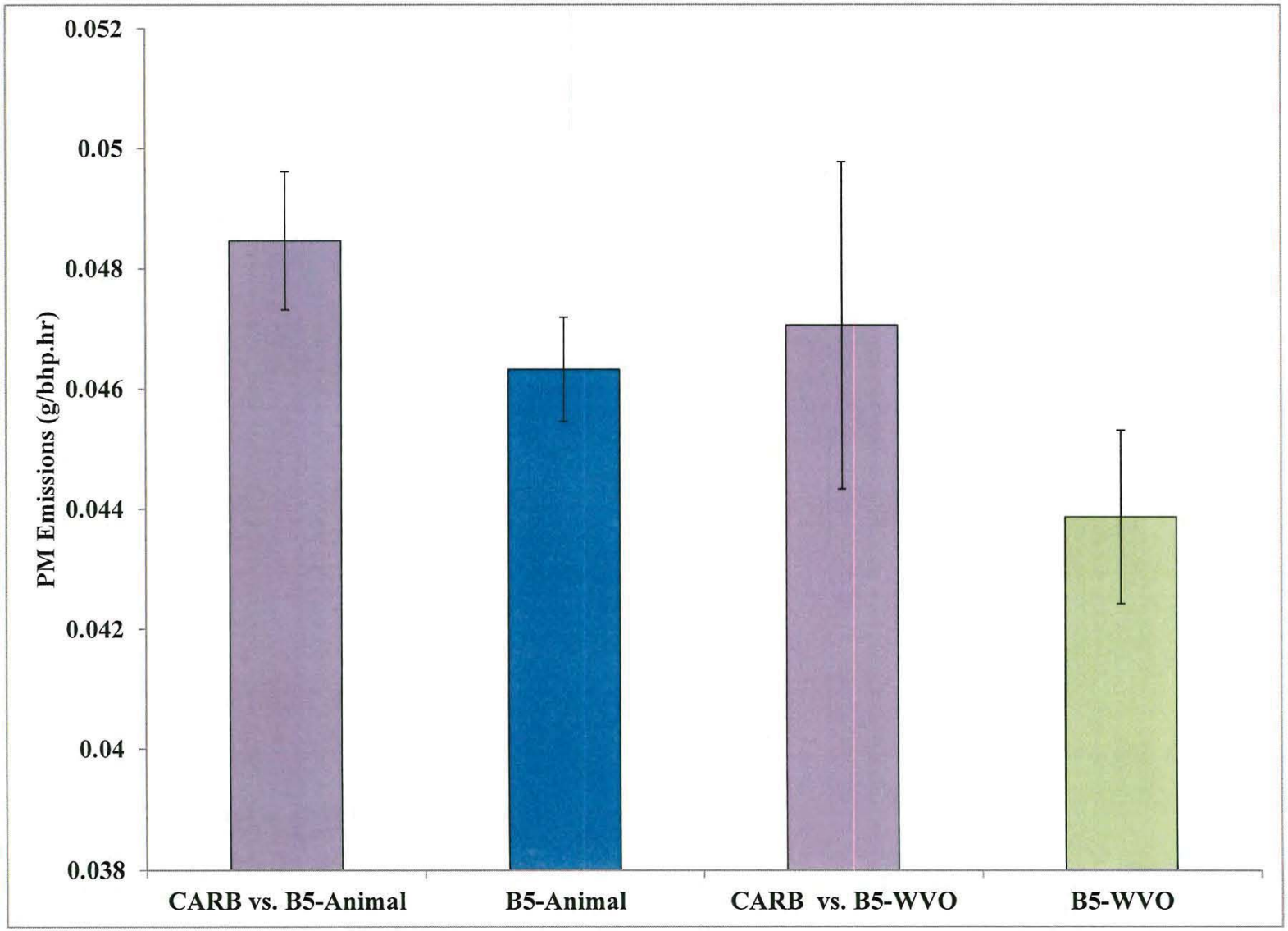
PM Emissions – Preliminary Testing of B5 Certification



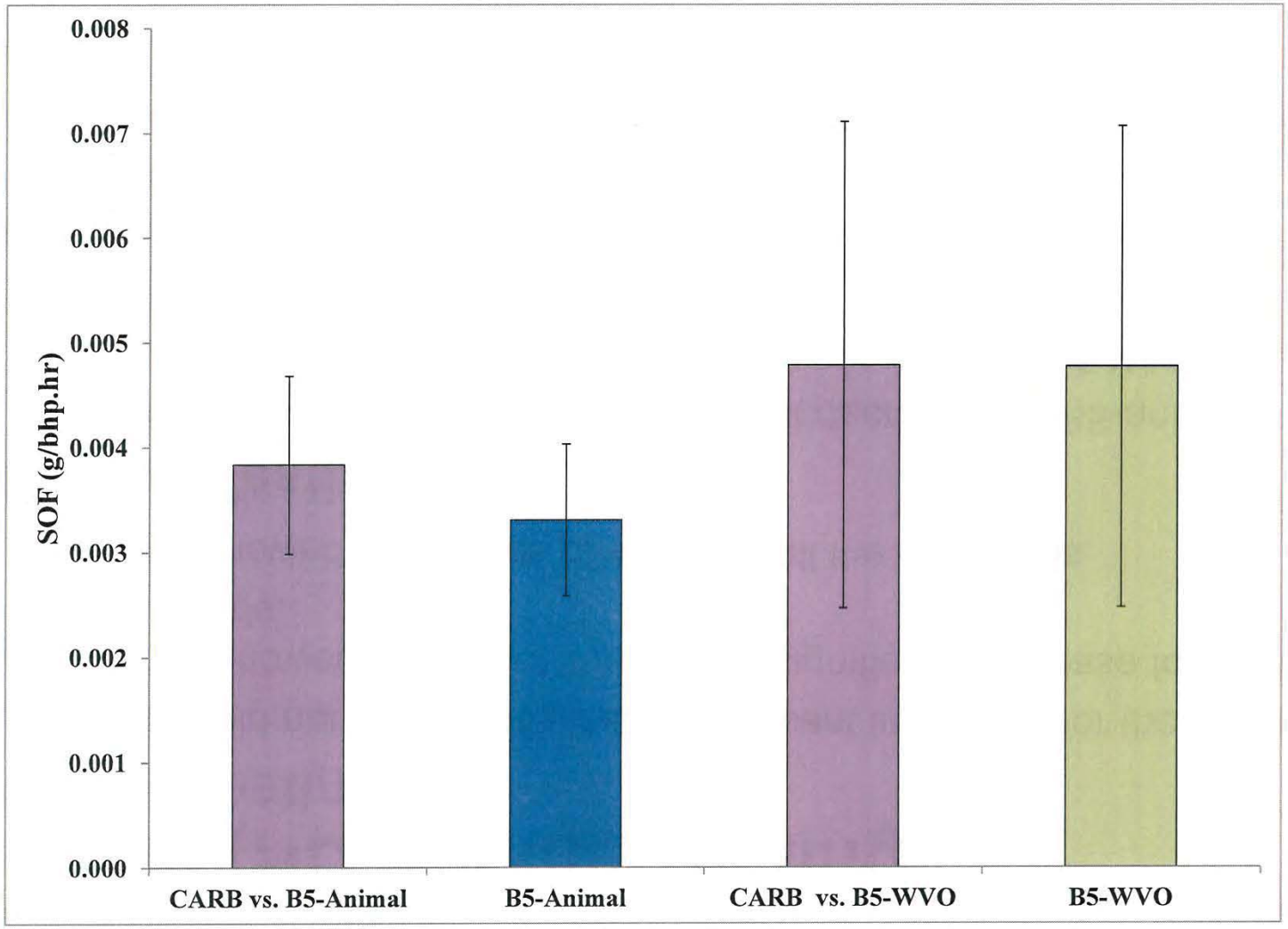
NO_x Emissions- Certification Testing



PM Emissions - Certification Testing



SOF Analysis- Certification Testing





Summary (HD Engine Testing)

Preliminary Testing

- NO_x emissions did not show statistically significant increases for the B5-animal.
- NO_x emissions showed slight, but statistically significant, increase for B5-WVO and B5-soy blends.
- PM emissions showed reductions of 4-6% for all the B5 blends.

Certification Testing

- NO_x emissions showed a statistically significant decrease for B5-animal.
- NO_x emissions showed a statistically significant increase for B5-WVO.
- PM showed reductions for both tested B5 blends.
- B5-animal showed a reduction in SOF compared to CARB reference fuel.
- The B5-animal successfully passed the certification statistical test.
- The B5-WVO failed the statistical certification test, based on NO_x emissions.

Additional work

- Further testing on B20 blends with additives has been conducted and is being analyzed.
- A more comprehensive study of the impacts of B5 on NO_x emissions in CARB diesel is planned in the near future.



Acknowledgements

- Funding from the California Air Resources Board (CARB) under contract No. 10-417.
- University of California Transportation Center (UCTC) Dissertation Grant
- Mr. Edward O'Neil, Mr. Donald Pacocha, Mr. Joe Valdez, and Mr. William Le Fevre of the University of California, Riverside for their contributions in conducting the emissions testing for this program.

3_B_ADF_GE Responses (Page 278 – 300)

222. Comment: **UCR Presentation**

Agency Response:
This document is UCR presentation on renewable and biodiesel testing. It does not constitute an objection or suggestion on the proposal; however the document was referenced in comment **ADF B3-114** and **ADF B3-115**. The responses to these comments are in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

AGENDA

23rd CRC REAL WORLD EMISSIONS WORKSHOP

Workshop Organizers

Mani Natarajan, Co-Chairman, Marathon Petroleum Company
Dominic DiCicco, Co-Chairman, Ford Motor Company
Alberto Ayala, California Air Resources Board
Brent Bailey, Coordinating Research Council
Megan Beardsley, U.S. Environmental Protection Agency OTAQ
Kevin Black, Federal Highway Administration
Rob R. Graze, Jr., Caterpillar, Inc. Technical Center
Philip Heirigs, Chevron Global Downstream
Jorn Dinh Herner, California Air Resources Board
Henry Hogo, South Coast Air Quality Management District
John Koupal, Eastern Research Group
Tom Long, U.S. Environmental Protection Agency NRMRL
Chris Tennant, Coordinating Research Council
Matthew Thornton, National Renewable Energy Laboratory

Hyatt Regency Mission Bay, San Diego, California
April 7-10, 2013

23rd CRC Real World Emissions Workshop

Schedule of Events

Sunday, April 7, 2013

4:30 PM - 6:00 PM	Registration and Poster Setup
6:00 PM - 7:00 PM	Welcome Reception

Monday, April 8, 2013

7:30 AM - 8:30 AM	Registration and Continental Breakfast
8:30 AM - 8:40 AM	Welcome from the Chairs
8:40 AM - 10:15 AM	**Session 1: Emission Rates and Inventory**
10:15 AM - 10:55 AM	Poster Session and Demonstrations
10:55 AM - 12:00 PM	**Session 2: Emissions Control Measures and Emerging Technologies**
12:00 PM - 1:30 PM	Lunch
1:30 PM - 2:15 PM	**Session 2 continued**
2:15 PM - 2:50 PM	**Session 3: I/M and In-Field Measurement Method Development**
2:50 PM - 3:20 PM	Poster and Demonstration Viewing
3:20 PM - 4:35 PM	**Session 3 continued**
4:35 PM	End of Day
6:00 PM - 9:30 PM	Evening Cruise of San Diego Harbor

Tuesday, April 9, 2013

7:30 AM - 8:00 AM	Registration and Continental Breakfast
8:00 AM - 8:50 AM	Keynote Speaker
8:50 AM - 9:40 AM	**Session 4: Emission Trends and Modeling**
9:40 AM - 10:20 AM	Poster and Demonstration Viewing
10:20 AM - 11:05 AM	**Session 4 continued**
11:05 AM - 12:10 PM	**Session 5: Laboratory Measurement Method Development**
12:10 PM - 1:40 PM	Lunch
1:40 PM - 2:55 PM	**Session 5 continued**
2:55 PM - 3:25 PM	Poster and Demonstration Viewing
3:25 PM - 5:15 PM	**Session 6: Particulate Matter Characterization**
5:15 PM	End of Day
5:30 PM - 6:30 PM	Poster Exhibition and Reception

Wednesday, April 10, 2013

7:30 AM - 8:00 AM	Registration and Continental Breakfast
8:00 AM - 10:05 AM	**Session 7: Off-Road**
10:05 AM - 10:35 AM	Poster and Demonstration Viewing
10:35 AM - 12:10 PM	**Session 8: Fuel Effects: Spark Ignition**
12:10 PM - 1:40 PM	Lunch
1:40 PM - 3:05 PM	**Session 9: Fuel Effects: Compression Ignition**
3:05 PM - 3:25 PM	Open Discussion
3:25 PM	End of Workshop

Welcome Sunday, April 07, 2013

4:30-6:00 pm	**Registration in Bayview Ballroom Foyer and Poster Setup in Mission Ballroom**		
6:00-7:00 pm	**Welcome Reception in the Cabanas**		

DAY ONE Monday, April 08, 2013

All sessions take place in Bayview Ballroom unless otherwise noted.

7:30 AM	**Registration in Bayview Ballroom Foyer** Continental Breakfast in Mission Ballroom		
8:30 AM	Welcome from the Chairs: Mani Natarajan, Marathon Petroleum Co., and Dominic DiCicco, Ford Motor Co.		

SESSION 1: Emission Rates and Inventory

8:40 AM	*Introduction by Session Leaders Henry Hogo, South Coast Air Quality Management District, and John Koupal, Eastern Research Group*		
■ 8:45 AM	Black Carbon and Primary Organic Aerosol Emissions From On-Road Gasoline and Diesel Vehicles	Robert Harley	University of California Berkeley
■ 9:00 AM	Trends in Heavy-Duty Truck Emissions in the South Coast Air Basin	Gary Bishop	University of Denver
■ 9:15 AM	Cold Temperature Measurement of Particulate and Gaseous Emissions from Tier 2 MSAT Vehicles	David Hawkins	U.S. Environmental Protection Agency
■ 9:30 AM	Characterization of Drayage Activities at the Port of Houston	Carl Fulper	U.S. Environmental Protection Agency
■ 9:45 AM	Integrated Emissions from 938 Heavy-Duty Vehicles under Realistic Driving Conditions in Vancouver Canada	Don Stedman	University of Denver
10:00 AM	General Discussion of Session 1		
10:15 AM	Poster Session and Demonstrations in Mission Ballroom *(see Pages 10-12 for Listings)*		

SESSION 2: Emissions Control Measures and Emerging Technologies

10:55 AM	*Introduction by Session Leader Jom Herner, California Air Resources Board*		
■ 11:00 AM	Phase 2 of the Advanced Collaborative Emissions Study (ACES): Highlights of Project Finding	Imad Khalek	Southwest Research Institute
■ 11:15 AM	Summary of Heavy-Duty Diesel Vehicle Selective Catalytic Reduction (SCR) Performance: Lessons to Date	John Collins	California Air Resources Board
■ 11:30 AM	The Air Quality Impacts of Trains in London Paddington Station	Uven Chong	University of Cambridge
■ 11:45 AM	Investigation on the Effect of Injection System Parameters on Emission Characteristics During Low Temperature Combustion Using Response Surface Methodology	Mario Velardi	West Virginia University
12:00 PM	Lunch in Red Marlin Restaurant		

■	1:30 PM	Quantification of Perturbation Effects on an Alternative Ignition System	Greg Yoder	West Virginia University
■	1:45 PM	Bivento.org - An Online Platform to Manage Real Traffic Emissions	Francisco Gala	Bivento-Technet
	2:00 PM	General Discussion of Session 2		

SESSION 3: I/M and In-Field Measurement Method Development

	2:15 PM	*Introduction by Session Leader Phil Heirigs, Chevron Global Downstream*		
■	2:20 PM	Assessing the Prevalence and Emissions Impact of High Emitters in California	Sherrie Sala-Moore	California Air Resources Board
■	2:35 PM	Results of Field Study of On-Board Diagnostic (OBD) Evaporative Codes	Carl Fulper	U.S. Environmental Protection Agency
	2:50 PM	Poster and Demonstration Viewing in Mission Ballroom *(see Pages 10-12 for Listings)*		
■	3:20 PM	Characterizing Emissions Reduction Performance and Test Methods of In-Use Diesel Retrofit Technologies from the National Clean Diesel Campaign	Britney McCoy	U.S. Environmental Protection Agency
■	3:35 PM	Synchronization of Portable Emissions Measurements Systems Data	Chris Frey	North Carolina State University
■	3:50 PM	Establishment of the PEMS-M Instrumentation Specifications for the In-Service Conformity of HDE in Europe	Athanasios Mamakos	Southwest Research Institute
■	4:05 PM	Evaluation, Quantification, and Performance of Accurate In-Use Fuel Economy Measurements	Kent Johnson	University of California, Riverside (CE-CERT)
	4:20 PM	General Discussion of Session 3		
	4:35 PM	**END OF DAY**		
	6:00 PM	Evening cruise of San Diego Harbor - meet in front of hotel lobby to board coaches. LAST BUS LEAVES AT 6:10 PM		

DAY TWO Tuesday, April 09, 2013

	7:30 AM	**Registration in Bayview Ballroom Foyer**		
		Continental Breakfast in Mission Ballroom		
	8:00 AM	KEYNOTE SPEAKER		
	SESSION 4:	**Emission Trends and Modeling**		
	8:50 AM	*Introduction by Session Leader Megan Beardsley, U.S. Environmental Protection Agency*		
■	8:55 AM	Improving the Accuracy of Modeling Compressed Natural Gas Transit Buses in MOVES	Andrew Eilbert	U.S. Environmental Protection Agency
■	9:10 AM	Projecting 2025 California Light-Duty Vehicle Fleet Emissions -- MOVES, EMFAC, and Suggested Updates	Robert Sawyer	University of California, Berkeley
■	9:25 AM	Current Analysis and Potential Updates to the EMFAC Model in California	Sam Pournazeri	California Air Resources Board
	9:40 AM	Poster and Demonstration Viewing in Mission Ballroom *(see Pages 10-12 for Listings)*		
■	10:20 AM	Updated Emissions Estimates for Pleasure Craft and Recreational Vehicles in California	David Chou	California Air Resources Board
■	10:35 AM	Development of a Simplified Version of MOVES and Incorporation into a Traffic Simulation Model	Chris Frey	North Carolina State University
■	10:50 AM	General Discussion of Session 4		
	SESSION 5:	**Laboratory Measurement Method Development**		
	11:05 AM	*Introduction by Session Leaders Kevin Black, Federal Highway Administration, and Matt Thornton, NREL*		
■	11:10 AM	Low PM Mass Assessment and Analysis E-99	Kent Johnson	University of California, Riverside (CE-CERT)
■	11:25 AM	An Analysis of Sub 1 mg/mi PM Mass from Light-Duty Vehicles	Jim Watson	California Air Resources Board
■	11:40 AM	A New Laboratory Method for Very Low Particular Mass Emissions Measurement	Jonathan Bushkuhl	AVL North America
■	11:55 AM	Particle Generator for Engine Exhaust Simulation	Imad Khalek	Southwest Research Institute
	12:10 PM	Lunch in Red Marlin Restaurant		
■	1:40 PM	Optimization of the Pegasor Particle Sensor for Automotive Exhaust Measurements	Leonidas Ntziachristos	Aristotle University
■	1:55 PM	Toward the Inclusion of FT-IR in the Certification of Engine Emissions for Both Standard and Alcohol-Based Fuel Blends	Richard Frazee	AVL North America
■	2:10 PM	Real-time Measurements of Metallic Ash Emissions from Engines	David Kittelson	University of Minnesota
■	2:25 PM	Impact of Modern Diesel Engine and Aftertreatment Technology on Test Repeatability and Emissions Prediction	Nigel Clark	West Virginia University CAFEE
	2:40 PM	General Discussion of Session 5		

2:55 PM Poster and Demonstration Viewing in Mission Ballroom *(see Pages 10-12 for Listings)*

SESSION 6: Particulate Matter Characterization

	3:25 PM	*Introduction by Session Leader Rob Graze, Caterpillar, Inc.*		
■	3:30 PM	Real-time DPF Filtration Efficiencies and Particle Number Emissions from Modern Diesel and Dual-Fueled HD Engines	Marc Besch	West Virginia University
■	3:45 PM	Morphology and Nanostructures of Particulates from an Engine-Simulating Particle Generator	Heeje Seong	Argonne National Laboratory
■	4:00 PM	Study of Variability in Particulate Mass Measurement and Comparison with Particle Number Count Measurement Method	Pragalath Thiruvengadam	West Virginia University
■	4:15 PM	Quantifying Particulate Matter Emissions from Gasoline and Diesel Vehicles: Gas Particle Portioning and Sampling Artifacts	Albert Presto	Carnegie Mellon University
■	4:30 PM	Physiochemical and Toxicological Properties of Size Segregated PM Emissions from a 2010 Compliant Heavy-Duty Diesel Truck - Is Diesel PM Still Diesel PM?	Jorn Herner	California Air Resources Board
■	4:45 PM	Investigation of Particle Size Distributions in a Exhaust Plume Emitted by Heavy-Duty Diesel Trucks at Cruise and Idling Operations	Presented by Mario Velardi for Daniele Littera	West Virginia University
	5:00 PM	General Discussion of Session 6		

5:15 PM **END OF DAY**

5:30 PM Poster Exhibition and Reception in the Mission Ballroom (5:30-6:30 pm)

DAY THREE Wednesday, April 10, 2013

	7:30 AM	**Registration in Bayview Ballroom Foyer** Continental Breakfast in Mission Ballroom		
	SESSION 7:	**Off-Road**		
	8:00 AM	*Introduction by Session Leader Alberto Ayala, California Air Resources Board*		
■	8:05 AM	Load Factors, Emission Factors, Duty Cycles, and Activity of Diesel Nonroad Vehicles	Tim DeFries	Eastern Research Group
■	8:20 AM	Emission Factors from In-Use Non-Road Construction Equipment Using 1065 Compliant PEMS	Tanfeng (Sam) Cao	University of California, Riverside (CE-CERT)
■	8:35 AM	Remote Sensing Measurements of In-Use Locomotive NOx Emissions	Matthew Breuer	University of Puget Sound
■	8:50 AM	Projected Growth for Ocean-Going Vessels	Louis Browning	ICF International
■	9:05 AM	Evaluation of Hybrid Retrofit System for a Tugboat	Nicholas Gysel	University of California, Riverside (CE-CERT)
■	9:20 AM	In-Use Measurement of Passenger Diesel Locomotive Emissions for Biodiesel and Petroleum Diesel Fuels	Christopher Frey	North Carolina State University
■	9:35 AM	Particulate Matter and Other Criteria Pollutants Reduced by Algae Fuels in Marine Vessels	Yusuf Khan	University of California, Riverside (CE-CERT)
	9:50 AM	General Discussion of Session 7		
	10:05 AM	Poster and Demonstration Viewing in Mission Ballroom *(see Pages 10-12 for Listings)*		
	SESSION 8:	**Fuel Effects: Spark Ignition**		
	10:35 AM	*Introduction by Session Leader Tom Long, U.S. Environmental Protection Agency*		
■	10:40 AM	Characterization of Particular Matter Emissions from Light-Duty Vehicles Technologies Using Physical, Chemical and Cellular Assays	Satya Sardar	California Air Resources Board
■	10:55 AM	Effects of Five Gasoline Properties on Exhaust Emissions from Light-Duty Tier 2 Vehicles	Aron Butler	U.S. Environmental Protection Agency
■	11:10 AM	Effects of Fuel Sulfur Level on Emissions from Tier 2 Vehicles in the In-Use Fleet	Aron Butler	U.S. Environmental Protection Agency
■	11:25 AM	Criteria Emissions, Toxic Pollutants, and Particle Number Emissions from Gasoline PFI and GDI Vehicles Operated on Ethanol and Isobutanol Blends	Daniel Short	University of California, Riverside (CE-CERT)
■	11:40 AM	A Comprehensive Evaluation of PM, NOx, Ammonia, and Greenhouse Gas Emissions from Current Model Year Heavy-Duty Vehicles	Arvind Thiruvengadam	West Virginia University
	11:55 AM	General Discussion of Session 8		

	12:10 PM	Lunch in Red Marlin Restaurant		
	SESSION 9:	**Fuel Effects: Compression Ignition**		
	1:40 PM	*Introduction by Session Leader Mani Natarajan, Marathon Petroleum Company*		
■	1:45 PM	Biodiesel and Renewable Diesel Characterization and Testing in Modern LD Diesel Passenger Cars and Trucks and HD Engines	Georgios Karavalakis	University of California, Riverside (CE-CERT)
■	2:05 PM	Emissions, Fuel Economy and Duty Cycle Testing and Analysis of Hybrid Electric Trucks Operating in the California Fleet	Matthew Thornton	National Renewable Energy Laboratory
■	2:20 PM	Hybrid and Electric Bus Emissions and Energy Test Program in South America	Sebastian Tolvett	Sistemas Sustentables
	2:35 PM	General Discussion of Session 9		
	2:50 PM	Open discussion - Mani Natarajan and Dominic DiCicco, Chairmen		
	3:25 PM	**END OF Workshop**		

Poster Exhibits

Emission Rates and Inventory

■ Measurement of Regulated and Greenhouse Gas Emissions from In-Use Vehicle Activity during a Cross-Continental Trip	Hemanth Kappanna [presented by Pragalath Thirvengadam]	West Virginia University
■ On-Board Measurement of Reduced-Nitrogen Emissions from Vehicles during Real-World Driving	John Moss	Oak Crest Institute of Science
■ Technology Significantly Lowers Emissions from Yard Tractors over Past 10 Years	Poornima Dixit	University of California, Riverside (CE-CERT)
■ Benchmarking Vehicle Fleet Performance: Real World Monitoring as an Everyday Activity	Stephen Hanley	University of Leeds Institute for Transport Studies
■ Emissions of Air Toxic Species from Light-Duty Vehicles with Gasoline Direct Injection (GDI) and Port Fuel Injection (PFI) Engines	Oliver Chang	California Air Resources Board
■ Idling Emissions from Recent Model Year Heavy-Duty Diesel Vehicles	Doh-Won Lee (presented by Josias Zietsman)	Texas A&M Transportation Institute
■ Contribution of Cold Starts to Real-World Total Trip Emissions for Light-Duty Gasoline Vehicles	Chris Frey	North Carolina State University

Emission Control Measures and Emerging Technologies

■ Exhaust Emissions Reductions Using a Seawater Scrubber on a Container Ship	Andrew Burnette	Infowedge
■ In-Use NOx Emissions from 2010 or Newer Heavy-Duty Diesel Engines Equipped with OEM Aftertreatment Devices	Chandan Misra [presented by John Collins]	California Air Resources Board
■ Update on Pase 2 of the Advanced Collaborative Emissions Study (ACES Phase 2)	Chris Tennant	Coordinating Research Council

I/M and In-Field Measurement Methods

■ Results of the TEDDIE Project and Future Developments Concerning Emissions Testing in Europe EmissionCheck 2020	Hans Juergen Maeurer	DEKRA Automobil GmBH Germany
■ Operational Challenges Faced During Vehicle Emissions Testing in Hong Kong	Kwok-Lam Ng	Hong Kong Environmental Protection Department
■ Evidence of Flipper Vehicles in Arizona Random Sample Triplicate IM147 Data	Tom Wenzel	Lawrence Berkeley National Laboratory
■ Ultrafine Particle Measurements and Evaluation of the Mobile Source Contribution in New York City	Robert Anderson	TSI, Inc.

■ Comparison of a Portable FTIR with SEMTECH-DS under Real-World Urban Driving Conditions	Eddie Lo	Hong Kong Environmental Protection Department
■ Relative Amounts of Gases in Exhaust Plumes by Laser Remote Sensing	Stewart Hager	HEAT, LLC
■ Off-Cycle Light-Duty Diesel Vehicle Emissions Measurement with PEMS: Project Description and Preliminary Data	Marc Besch	West Virginia University

Emission Trends and Modeling

■ Methodology to Predict Real World Aerodynamic Drag Losses Due to On-Road Cross-Wind Effects	Nigel Clark	West Virginia University

Laboratory Measurement Methods Development

■ An Analysis of Light-Duty Vehicle PM Data Generated in CARB HSL Cell 2 and Cell 3	Mang Zhang	California Air Resources Board
■ Time-Resolved FTIR Measurements of Non-Methane Organic Gases (NMOG) in Vehicle Exhaust Gas	Christine Gierczak	Ford Motor Company
■ Pulse Height Monitor to Improve Data Reliability of Condensation Particle Counter for Engine Emission Applications	Tim Johnson	TSI, Inc.
■ Measurement of Dioxin Formation in Heavy-Duty Diesel Engines	Robert Fanick	Southwest Research Institute
■ ~~Variability of PM Mass Measurement for Two Sub 1 Mg/Mi Vehicles~~ (withdrawn)	~~Satya Sardar~~	~~California Air Resources Board~~
■ Onsite Checks on Particle Number Equipment	Manfred Linke	AVL List GmbH

Particulate Matter Characterization

■ Determination of Suspended Exhaust PM Mass for Light-Duty Vehicles	Heejung Jung	University of California Riverside (CE-CERT)
■ Insight Into Detailed Properties of Nano-Particles from Various Engine Combustion Sources	Kyeong Lee	Argonne National Laboratory

Off-Road

■ Real-World In-Use Tailpipe Emissions Measurements of Over the Snow Vehicles at Yellowstone National Park	Christopher Frey	North Carolina State University
■ Hybrid Off-Road Equipment Evaluation: Part 1 - Duty Cycle Development	Tangfeng (Sam) Cao	University of California Riverside (CE-CERT)

■ Techniques for the Convenient Off-Road Monitoring an dEnforcement of Heavy-Duty Vehicle Exhaust Emissions	Peter McClintock	Applied Analysis
■ Characterization of Real-World Emissions from Heavy Haulers in Canadian Oil Sands Mining	Xiaoliang Wang	Desert Research Institute

Fuel Effects: Compression Ignition

■ Effect of Biodiesel Feedstock on Regulated Emissions, Gaseous Toxics, and Ultrafine Particles from Two Trucks Fitted With and Without Aftertreatment Controls	Nicholas Gysel	University of California Riverside (CE-CERT)

Fuel Effects: Spark Ignition

■ Impact of Natural Gas Fuel Composition on Criteria and Toxic Emissions from Transit Buses	Maryam Hajbabaei	University of California Riverside (CE-CERT)

Demonstrations

■ TSI Engine Emissions Solutions	Tim Johnson Bob Anderson	TSI, Inc.
■ Photoacoustic Measurement of Black Carbon Emissions	Gavin McMeeking	Droplet Measurement Technologies
■ Particle Mass and Particle Number Measurement for Automotive Engine and Aircraft Turbine Applications	Siegfried Roeck	AVL
■ RDE Real Driving Emissions Measurement with AVL PEMS Equipment*	Siegfried Roeck	AVL
■ Sensors, Inc.	Robert Wilson	Sensors, Inc.
■ Dekati and Pegasor Instruments for PM Sampling, Conditioning, and Analysis	Tyler Beck	Particle Instruments
■ Real-World Emissions Testing Based on FTIR Technology	Ron Tandy	A&D Technology

*This demonstration is located in the parking lot outside the ballroom.

Chairmen

■ Mani Natarajan, Co-Chairman, Marathon Petroleum Company

Mani Natarajan is currently working at Marathon Petroleum Company as a Fuels Technology Advisor. He is leading a CRC project on biodiesel and renewable diesel characterization in modern LD diesel passenger cars and trucks. He is currently the co-chairman of the CRC Real World Emissions and Emissions Modeling Group. He is a member of the CRC Emissions Committee, CRC AVFL Committee, CRC Atmospheric Impacts Committee and API Vehicle Emissions Group. Over the past 23 years, he has been very active in CRC and API projects, conducting fuels/emissions-related research. He has a B.S and M.S. in Chemistry and a M.S. and Ph.D. in Chemical Engineering. He was an Associate Professor at the College of Engineering, The University of Toledo. Previously, as Manager of Research at Surface Combustion, he led projects in advanced combustion, renewable energy and heat treatment. He was a consultant for Pratt & Whitney in the super alloy manufacturing development of the Integrally Bladed Rotors (IBR) for jet engines. He is a member of SAE, AIChE and ACS.

■ Dominic DiCicco, Co-Chairman, Ford Motor Company

Dominic DiCicco was recently appointed to the position of Environmental Policy Manager in the Sustainability and Vehicle Environmental Matters Division at Ford Motor Company. His new role involves supporting the execution of Ford Motor Company's strategic product plans as well as topics of mutual interest on improving fuel quality and regulations, requiring interaction with the US Environmental Protection Agency (US EPA), California Air Resources Board (CARB) and other government entities around the world. Mr. DiCicco is the co-chairman of the CRC Real World Emissions and Emissions Modeling Group and serves as a member on both the CRC Emissions Committee and CRC AVFL Committee. He is a Ford representative on the Fuels Working Group of United States Council for Automotive Research (USCAR), the Alliance of Automobiles and other industry-related efforts. Recent and past major projects have included key roles in working towards the successful reduction in sulfur content in fuels, elimination of manganese across the Canadian marketplace and more recently in the evaluation of mid-level ethanol blends (such as E15 and E20). His career with Ford Motor Company is nearly 20 years young, more than half this time supporting fuels after starting at the Ford Research Laboratory in the Chemical Engineering Department researching exhaust emission catalytic systems. Mr. DiCicco holds a M.S. and B.S. in Chemical Engineering and a B.A. in Chemistry, all from Wayne State University.

Session Leaders

■ Alberto Ayala, California Air Resources Board

Alberto Ayala was appointed as Deputy Executive Officer of the California Air Resources Board at the end of 2012. In this capacity, Alberto is responsible for the Board's ambient monitoring and laboratories and mobile source control and operations programs. Alberto became a member of CARB's research staff in 2000 and has since held various management assignments in programs such as Carl Moyer Incentives, AB 32 early actions, mobile refrigerant rules, diesel retrofits, and car, truck, and bus emissions research. Most recently he served as Chief of the Monitoring and Laboratory Division. Alberto oversees the full range of policy, regulatory, and research efforts of over 400 professionals focused on achieving CARB's goals for clean, zero-emission, and low-carbon transportation; state-of-the-art monitoring for air and climate pollution; and a widely recognized motor vehicle emissions and fuels testing program. He contributed to the first car GHG emissions regulation in 2004 and is now directing one of CARB's most important efforts, the advanced clean cars program.

Prior to CARB, Alberto was a member of the engineering faculty at West Virginia University, where he now holds an adjunct appointment, and was an ordnance system design engineer for Teledyne Ryan Aeronautical. He holds B.S., M.S., and Ph.D. degrees in Mechanical Engineering from the University of California, Davis. His internships were with GE, the California Energy Commission, and the Atmospheric Boundary Layer Wind Tunnel Laboratory at UC Davis. He has published extensively, been a speaker nationally and internationally, and lectured as a Visiting Professor in California and abroad.

■ Megan Beardsley, US Environmental Protection Agency OTAQ

Megan Beardsley is an environmental scientist in the Air Quality & Modeling Center within the Assessment and Standards Division of EPA's Office of Transportation and Air Quality. Her group is responsible for the development of mobile source models, including MOVES and NONROAD, and supporting EPA programs and policies through emissions and activity research, policy analysis, emissions inventory development and air quality modeling support. Megan has worked for EPA since 1992. She has an interdisciplinary B.S. from Stanford University and an M.S. in Resource Policy from the University of Michigan.

■ Kevin Black, Federal Highway Administration

Kevin Black is a Highway Engineer working as an Air Quality Analyst on air quality issues for the Federal Highway Administration's Resource Center in Baltimore. He has a B.A. in Geography from George Mason University, a B.S. in Civil Engineering from Virginia Tech and an M.S. in Civil Engineering from George Mason University. He has worked in several offices within FHWA, including the Office of Research, the Office of Engineering, the Office of Natural and Human Environment, and currently the Resource Center. His present position is responsible for analyzing the environmental impacts of air pollutants in support of FHWA air quality policy.

■ R. Rob Graze, Jr., Caterpillar, Inc. Technical Center

Rob Graze is degreed in Physics with additional study in Mechanical Engineering. His Research Background includes work in the areas of tribology, lube system and bearing design, diesel and large SI engine combustion development , particulate and gaseous emissions measurement, and partial flow dilution system design and refinement.

■ Philip Heirigs, Chevron Global Downstream

Phil Heirigs, a native of California, holds a B.S. in Engineering and a M.S. in Chemical Engineering from the University of California, Los Angeles, and is a licensed Professional Engineer in the state. His professional career began with a short stint in the nuclear power industry, which was followed by nearly seven years with the California Air Resources Board. Mr. Heirigs then spent 15 years at Sierra Research, a Sacramento-based consulting firm. In June 2007, Mr. Heirigs joined Chevron, where his key responsibilities have included the analysis of issues related to the life cycle assessment of transportation fuels, vehicle fuel economy, advanced vehicle technologies and costs, transportation fuel demand, the impact of fuel specification changes on vehicle emissions, and vehicle emissions modeling.

■ Jorn Dinh Herner, California Air Resources Board

Jorn Herner has worked for the last eight years at the California Air Resources Board. In his current position as Chief of the Research Planning and Emission Mitigation Branch in the Research Division, he oversees the division's extramural research program, the implementation of measures to reduce greenhouse gases, and the vehicle emissions research program. His main research interests are the effect of new emission control technologies and fuels and the relative toxicity of emissions from various combustion sources. Jorn has a B.A. and M.S. from the University of California, Berkeley, and earned his Ph.D. in Civil and Environmental Engineering from the University of California, Davis.

■ Henry Hogo, South Coast Air Quality Management District

Henry Hogo is the Assistant Deputy Executive Officer for the Mobile Source Division in the Office of Science and Technology Advancement at the South Coast Air Quality Management District (SCAQMD). Mr. Hogo received a Bachelor of Science degree in chemistry from the University of California, Berkeley, and has been working in the air pollution field for over 35 years. As Assistant Deputy Executive Officer in the Mobile Source Division, Mr. Hogo is responsible for the implementation of the District's Clean Fleet Vehicle Rules, development of mobile source strategies for the SCAQMD's air quality management plans, analysis of mobile source emissions impacts on air quality, and providing input on state and federal mobile source regulations.

■ John Koupal, Eastern Research Group

John Koupal is a Principal Engineer with Eastern Research Group, Inc. (ERG) with over twenty years of experience in mobile source emission research, policy, modeling and inventory development in the U.S. and abroad. Prior to joining ERG, Mr. Koupal served many roles within the U.S. EPA's Office of Transportation and Air Quality, including directing the group responsible for mobile source modeling and emission inventory development, providing technical and analytical support for several EPA rules, and leading the development of the MOVES model. Mr. Koupal worked for Nissan from 1995-1997 on emissions certification and regulatory issues. Mr. Koupal was named to the Advisory Committee on the National Mobile Source Emission Inventory of China in 2010, and the Board of Advisors for UC Riverside?s Center for Environmental Research and Technology (CE-CERT) in 2012. Mr. Koupal graduated from the University of Michigan with a Bachelor's Degree in Industrial and Operations Engineering in 1989.

■ Tom Long, US Environmental Protection Agency NRMRL

Tom Long received his M.S. in Engineering from West Virginia University, where he worked with Nigel Clark on the design of the first heavy-duty mobile dynamometer. Later, he served as the West Coast Coordinator for West Virginia's Center for Alternative Fuels, Engines, and Emissions (CAFEE). After working as a contractor to the U.S. EPA in RTP, North Carolina, Tom was hired by the government to coordinate the dynamometer facility operated by the EPA's Office of Research and Development. His area of research includes the measurement of mobile source emissions using both stationary and chassis dynamometer, PEMS, and near road stationary sites. He is particularly interested in fuel and temperature effects on the quantity and characteristics of mobile source emissions.

■ Matthew Thornton, National Renewable Energy Laboratory

Matt Thornton is a principal research engineer at the National Renewable Energy Laboratory. He received his Ph.D. from Georgia Institute of Technology. He is involved in testing and analysis research programs that assess the fuel economy and performance impacts of advanced fuels and powertrains for light- and heavy-duty vehicles, and is currently the acting director for NREL's Center for Transportation Technologies and Systems.


CRC

3_B_ADF_GE Responses (Page 301 – 316)

223. Comment: **CRC Emissions Workshop Agenda**

Agency Response:
This document is an agenda from the April 2013 CRC Emissions Workshop. It does not constitute an objection or suggestion on the proposal; however the document was referenced in comment **ADF B3-115**. The response to this comment is in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

ATTACHMENT C

Comments of Growth Energy on the Air Resources Board Staff Presentations at a Public Consultation Meeting on Regulations for Commercialization of Alternative Diesel Fuels

These comments respond to the CARB staff's request for comments on the staff's presentations at the April 17, 2014 public consultation meeting on the proposed adoption of regulations to govern commercialization of alternative diesel fuels, including as part of compliance strategies for the California low-carbon fuel standard ("LCFS") regulation.

1. CARB-Sponsored and Related Emissions Testing and Research

During the April 17th meeting, CARB staff indicated that the agency had an "ongoing" study of the emission impacts of B5 and B10 blends underway and that data from that study would be released to the public and incorporated into the rulemaking process. Incorporation of this data into the rulemaking process is essential in order to comply with the Global Warming Solutions Act of 2006 and other statutes that apply to CARB's implementation of the 2006 Act.[1] CARB must provide not only a full report on that study, but also all data that it has obtained in connection with the study and related materials. Nearly four weeks have passed since the April 17th public meeting and, to Growth Energy's knowledge, the CARB staff has not met its commitments.[2] Growth Energy and other stakeholders will need sufficient time to review the data and related materials in order to participate effectively in the ADF and LCFS rulemakings. Also during the course of the workshop, CARB staff indicated that two other agency-sponsored studies of biodiesel blends had been conducted but not yet released to the public. Again, all

ADF B3-122

[1] *See, e.g.*, Cal. Health & Safety Code § 38562(e) ("The state board shall rely upon the best available ... scientific information ... when adopting regulations required by this section."); *see also id.* § 38563(b)(4) (regulations to implement the 2006 Act must not "interfere with[] efforts to achieve and maintain federal and state ambient air quality standards."). The California Environmental Quality Act's requirements likewise cannot be met unless CARB considers all relevant data on the potential of biodiesel usage to increase NOx emissions.

[2] Much of the data from this study and related materials may also be responsive to a Public Records Act request that Growth Energy has filed with CARB, but no data and very few related materials have been released to date.

reports as well as underlying data and other relevant materials must be made publicly available. All these materials, from each study, must be placed in a public rulemaking file without further delay, pursuant to subsections 6 and 7 of section 11347.3(a) of the Government Code.

ADF B3-122 cont.

2. Methodology to Establish a Significance Threshold and Related Issues

To date, CARB staff has indicated that it has attempted to identify a significance threshold for biodiesel blends by comparing emissions results when engines are tested on nominally specific biodiesel blends, and when the same engines are tested in similar ways on fuel containing no diesel. The defect in such a method is that it does not permit assessment of emissions when engines are operated on biodiesel blends other than those tested, including, for example, biodiesel blends below B5. The appropriate method to determine the significance threshold is contained in an analysis prepared for Growth Energy by Mr. Robert Crawford and placed in the rulemaking file last year.[3] After evaluating the linearity and statistical significance of the relationship between NOx emissions and biodiesel content, Mr. Crawford demonstrates that use of biodiesel even at levels below B5 will result in increased NOx emissions. CARB should adopt Mr. Crawford's approach to establishing the significance threshold for biodiesel, or explain in full any reasons for not doing so.

ADF B3-123

Despite the fact that CARB staff has correctly chosen to propose mitigation of biodiesel NOx impacts on a per-gallon basis in extreme ozone non-attainment areas, this issue is important because the use of the current methodology for establishing the significance level will not prevent significant increases in NOx emissions in these areas.

ADF B3-124

[3] Crawford, R., "NOx Emission Impact of Soy- and Animal-based Biodiesel Fuels: A Re-Analysis," December 10, 2013.

3. Protection of the Environment on a Statewide Basis

Based on the presentation at the recent public consultation meeting, CARB staff continues to propose the highly flawed "effective blend" approach for determining the point at which mitigation of biodiesel NOx impacts would be required under the proposed ADF regulation. Instead, CARB staff should also require the per-gallon mitigation concept proposed for extreme ozone nonattainment areas and the appropriate significance threshold to be used in all other areas of the state.

ADF B3-125

4. Minimum Requirements to Determine and Report Blend Levels

The CARB staff's presentation at the recent meeting did not clarify how the proposed ADF regulation will ensure that the biodiesel content of blends sold in California will be accurately known to fuel purchasers or reported to CARB. At present, CARB appears to have no requirement for determining the biodiesel content of diesel fuels being imported or distributed in the state that contain biodiesel up to the B5 level. Given this, a party interested in blending 5% biodiesel into a "diesel" fuel may be unaware of the fact that the "diesel" fuel could already contain up to 5% biodiesel and that the resulting blend would therefore be B10, not B5. Similarly, a party interested in blending 20% biodiesel into a "diesel" could in fact produce a B25 blend, instead of the intended B20 blend. Obviously, both circumstances have substantial ramifications with respect to potential NOx increases associated with the use of biodiesel in California.

ADF B3-126

Given the above, CARB must modify as necessary its existing diesel fuel regulations as well as the proposed ADF regulations to ensure that the biodiesel content of all blends of biodiesel and diesel sold in California is accurately known and reported to both CARB as well as the Division of Measurement Standards. This could easily be accomplished by requiring that all

ADF B3-127

"diesel" fuels used in biodiesel blends be tested before blending for Fatty Acid Methyl Ester ("FAME") content using appropriate test procedures such as the EN14103:2011 procedure already referenced in the proposed ADF regulations or the ASTM D7371 procedure. Alternatively, CARB could require testing of final blends for FAME content. Again, failure by CARB to require accurate measurement and reporting of the biodiesel content of biodiesel-diesel blends will lead to unmitigated increases in NOx emissions along with other potential issues, including violations of pump labeling and vehicle manufacturer warranty requirements.

ADF B3-127 cont.

Respectfully submitted,

GROWTH ENERGY

3_B_ADF_GE Responses (Page 317 – 321)

224. Comment: **ADF B3-123 through ADF B3-125**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

225. Comment: **ADF B3-122**
The comment states that all appropriate scientific data should be made available to the public in a timely manner.

Agency Response:
The comment is related to the April 17, 2014 pre-rulemaking workshop. For information on ARB's policy on public participation, please see **ADF 5-3** and **ADF F5-2**.

226. Comment**: ADF B3-126**
The comment questions whether or not the ADF proposal ensures that biodiesel content of blends sold in California will be accurately known.

Agency Response**:**
Please see discussion of biodiesel blending in response **ADF 17-8**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

227. Comment**: ADF B3-127**
The comment states that ARB must modify the existing ADF proposal to ensure that the biodiesel content of blends is accurately known and reported to ARB and the Division of Measurement Standards.

Agency Response:
Please see biodiesel blending in response **ADF 17-8,** in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

NOx Emissions Impact of Soy- and Animal-based Biodiesel Fuels: A Re-Analysis

December 10, 2013

Prepared for:

Sierra Research
1801 J Street
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Prepared by:

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NOX EMISSIONS IMPACT OF SOY- AND ANIMAL-BASED BIODIESEL FUELS: A RE-ANALYSIS

prepared for:

Sierra Research, Inc.

December 10, 2013

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NOX IMPACT OF SOY- AND ANIMAL-BASED BIODIESEL FUELS: A RE-ANALYSIS

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1. EXECUTIVE SUMMARY

1.1 Background on the Proposed Rule

The California Air Resources Board (CARB) has proposed regulations on the commercialization of alternative diesel fuel (ADF) that were to be heard at the December 2013 meeting of the Board. The proposed regulations seek to "... create a streamlined legal framework that protects California's residents and environment while allowing innovative ADFs to enter the commercial market as efficiently is possible."[1] In this context ADF refers to biodiesel fuel blends. Biodiesel fuels are generally recognized to have the potential to decrease emissions of several pollutants, including hydrocarbons (HC), carbon monoxide (CO), and particulate matter (PM), but are also recognized to have the potential to increase oxides of nitrogen (NOx) unless mitigated in some way. NOx emissions are an important precursor to smog and have historically been subject to stringent emission standards and mitigation programs to prevent growth in emissions over time. A crucial issue with respect to biodiesel is how to "... safeguard against potential increases in oxides of nitrogen (NOx) emissions."[2]

The proposed regulations are presented in the Staff Report: Initial Statement of Reasons (ISOR) for the Proposed Regulation on the Commercialization of New Alternative Diesel Fuels[3] (referenced as ISOR). Chapter 5 of the document describes the proposed regulations, which exempt diesel blends with less than 10 percent biodiesel (B10) from requirements to mitigate NOx emissions:

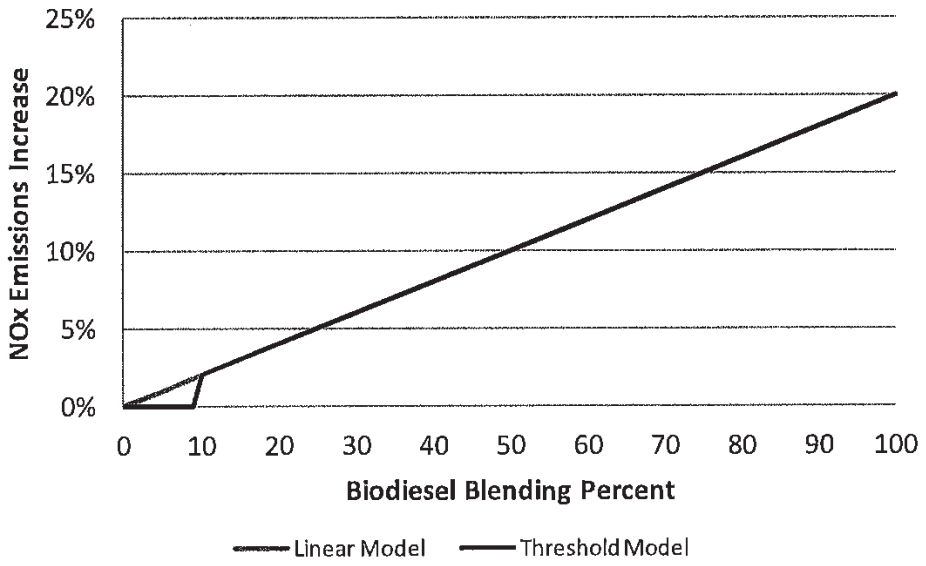
> There are two distinct blend levels relative to biodiesel that have been identified as important for this analysis. Based on our analysis to date, we have found that diesel blends with less than 10 percent biodiesel by volume (<B10) have no significant increase in any of the pollutants of concern and therefore will be regulated at Stage 3B (Commercial Sales not Subject to Mitigation). However, we have found that biodiesel blends of 10 percent and above (≥B10) have potentially significant increases in NOx emissions, in the absence of any mitigating factors, and therefore those higher blend levels will be regulated under Stage 3A (Commercial Sales Subject to Mitigation).[4]

Reproduction of
Pages 167 - 204
Consisting of
Comments ADF B3-146
through ADF B3-92

[1] "Notice of Public Hearing to Consider Proposed Regulation on the Commercialization of New Alternative Diesel Fuels." California Air Resources Board, p. 3. http://www.arb.ca.gov/regact/2013/adf2013/adf2013notice.pdf.
[2] Ibid. p. 3.
[3] "Proposed Regulation on the Commercialization of New Alternative Diesel Fuels. Staff Report: Initial Statement of Reason." California Air Resources Board, Stationary Source Division, Alternative Fuels Branch. October 23, 2013. http://www.arb.ca.gov/regact/2013/adf2013/adf2013isor.pdf.
[4] Ibid, p. 22.

Existing research on the NOx emission effects of biodiesel has consistently been conducted under the hypothesis that the emission effect will be linearly proportional to the blending percent of neat biodiesel (B100) with the base diesel fuel. The Linear Model that has been accepted by researchers is shown as the blue line in Figure 1-1. The Staff position cited above is that biodiesel fuels do not increase NOx emissions until the fuel blend reaches 10% biodiesel. This so-called Staff Threshold Model departs from the Linear Model that underlies past and current biodiesel research by claiming that NOx emissions do not increase until the biodiesel content reaches 10 percent.

Figure 1-1
Linear and Staff Threshold Models for Biodiesel NOx Impacts



The Staff Threshold model is justified by the statement: "Based on our analysis to date, we have found that diesel blends with less than 10 percent biodiesel by volume (<B10) have no significant increase in any of the pollutants of concern." Other portions of the ISOR state that Staff will track "... the effective blend level on an annual statewide average basis until the effective blend level reaches 9.5 percent. At that point, the biodiesel producers, importers, blenders, and other suppliers are put on notice that the effective blend-level trigger of 9.5 percent is approaching and mitigation measures will be required once the trigger is reached."[5] Until such time, NOx emission increases from biodiesel blends below B10 will not require mitigation.

Section 6 of the ISOR presents a Technology Assessment that includes a literature search the Staff conducted to obtain past studies on the NOx impact of biodiesel in heavy-duty

[5] Ibid, p. 24.

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engines using California diesel (or other high-cetane diesel) as a base fuel. Section 6.d presents the results of the literature search with additional technical information provided in Appendix B. The past studies include the Biodiesel Characterization and NOx Mitigation Study[6] sponsored by CARB (referenced as Durbin 2011).

The results of the Staff literature search are summarized in Table 1-1, which has been reproduced from Table 6.1 of the ISOR. For B5 and B20, the data represent averages for a mix of soy- and animal-based biodiesels, which tend to have different impacts on NOx emissions (animal-based biodiesels increase NOx to a lesser extent). For B10, the data represent an average for soy-based biodiesels only. Staff uses the +0.3% average NOx increase at B5 in comparison to the 1.3% standard deviation to conclude:

> Overall, the testing indicates different NOx impacts at different biodiesel percentages. Staff analysis shows there is a wide statistical variance in NOx emissions at biodiesel levels of B5, providing no demonstrable NOx emissions impact at this level and below. At biodiesel levels of B10 and above, multiple studies demonstrate statistically significant NOx increases, without additional mitigation.[7]

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Table 1-1 Results of Literature Search Analysis		
Biodiesel Blend Level	NOx Difference	Standard Deviation
B5	0.3%	1.3%
B10[a]	2.7%	0.2%
B20	3.2%	2.3%

Source: Table 6.1 of Durbin 2011
Notes:
[a] Represents data using biodiesel from soy feedstocks.

The Staff conclusion is erroneous because it relies upon an apples-to-oranges comparison among the blending levels. Each of the B5, B10, and B20 levels include data from a different mix of studies, involving different fuels (soy- and/or animal-based), different test engines, and different test cycles. The B5 values come solely from the CARB Biodiesel Characterization study, while the B10 values come solely from other studies. The B20 values are a mix of data from the CARB and other studies. The results seen in the table above are the product of the uncontrolled aggregation of different studies that produces incomparable estimates of the NOx emission impact at the three blending levels.

[6] "CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California: Biodiesel Characterization and NOx Mitigation Study." Prepared by Thomas D. Durbin, J. Wayne Miller and others. Prepared for Robert Okamoto and Alexander Mitchell, California Air Resources Board. October 2011.
[7] ISOR, p. 32.

As will be demonstrated in this report, the Staff conclusion drawn from the data in Table 1-1 is not supported by past or current biodiesel research, including the recent testing program sponsored by CARB. In fact, past and current studies indicate that biodiesel blends at any level will increase NOx emissions in proportion to the blending percent unless specifically mitigated by additives or other measures.

1.2 Summary and Conclusions

The following sections of this report examine the studies cited by CARB one-by-one. As evidenced from this review, it is clear that the data do not support the Staff conclusion and, indeed, the data refute the Staff conclusion in some instances. Specifically:

- There is no evidence supporting the Staff conclusion that NOx emissions do not increase until the B10 level is reached. Instead, there is consistent and strong evidence that biodiesel increases NOx emissions in proportion to the biodiesel blending percent.

- There is clear and statistically significant evidence that biodiesel increases NOx emissions at the B5 level in at least some engines for both soy- and animal-based biodiesels.

Considering each of the six past studies obtained from the technical literature and their data on high-cetane biodiesels comparable to California fuels, we find the following:

1. None of the six studies measured the NOx emissions impact from biodiesel at blending levels below B10. Only two studies tested a fuel at the B10 level. All other testing was at the B20 level or higher. Because none tested a B5 (or similar) fuel, none of them can provide direct evidence that NOx emissions are not increased at B5 or other blending levels below B10.

2. These studies provide no data or evidence supporting the validity of the Staff's Threshold Model that biodiesel below B10 does not increase NOx emissions. In fact, all of the studies are consistent with the contention that biodiesel increases NOx emissions in proportion to the blending percent.

3. Two of the studies present evidence and arguments that the NOx impact from biodiesel is a continuous effect that is present even at very low blending levels and will increase at higher levels in proportion to the blending percentage.

Considering the CARB Biodiesel Characterization report, we find that:

4. For the three engines where CARB has published the emission values measured in engine dynamometer testing, all of the data demonstrate that biodiesel fuels significantly increase NOx emissions for both soy- and animal-based fuels by amounts that are proportional to the blending percent. This is true for on-road and off-road engines and for a range of test cycles.

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5. Where B5 fuels were tested for these engines, NOx emissions were observed to increase. NOx emission increases are smaller at B5 than at higher blending levels and the observed increases for two engines were not statistically significant by themselves based on the pair-wise t-test employed in Durbin 2011.[8] However, the testing for one of the engines (the 2007 MBE4000) showed statistically significant NOx emission increases at the B5 level for both soy- and animal-based blends.

By itself, the latter result is sufficient to disprove the Staff's contention that biodiesel blends at the B5 level will not increase NOx emissions.

Based on examination of all of the studies cited by CARB as the basis for its proposal to exempt biodiesels below B10 from mitigation, it is clear that the available research points to the expectation that both soy- and animal-based biodiesel blends will increase NOx emissions in proportion to their biodiesel content, including at the B5 level. CARB's own test data demonstrate that B5 will significantly increase NOx emissions in at least some engines.

Based on data in the CARB Biodiesel Characterization report, soy-based biodiesels will increase NOx emissions by about 1% at B5 (and 2% at B10), while animal-based biodiesels will increase NOx emissions by about one-half as much: 0.45% at B5 (and 0.9% at B10). All of the available research says that the NOx increases are real and implementation of mitigation measures will be required to prevent increases in NOx emissions due to biodiesel use at blending levels below B10.

Finally, we note that CARB has not published fully the biodiesel testing data that it relied on in support of the Proposed Rule and thereby has failed to adequately serve the interest of full public disclosure in this matter. The CARB-sponsored testing reported in Durbin 2011 is the sole source of B5 testing cited by CARB as support for the Proposed Rule. Durbin 2011 publishes only portions of the measured emissions data in a form that permits re-analysis; it does not publish any of the B5 data in such a form. It has not been possible to obtain the remaining data through a personal request to Durbin or an official public records request to CARB and, to the best of our knowledge, the data are not otherwise available online or through another source.

CARB should publish all of the testing presented in Durbin 2011 and any future testing that it sponsors in a complete format that allows for re-analysis. Such a format would be (a) the measured emission values for each individual test replication; or (b) averages across all test replications, along with the number of replications and the standard error of the individual tests. The first format (individual test replications) is preferable because that would permit a full examination of the data including effects such as test cell drift over time. Such publication is necessary to assure that full public disclosure is achieved and that future proposed rules are fully and adequately informed by the data.

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[8]As discussed in Section 3.3, the pair-wise t-test is not the preferred method for demonstrating statistical significance.

1.3 Review of 2013 CARB B5 Emission Testing

In December 2013, after the release of the ISOR and in response to an earlier Public Records Act request, CARB released a copy of new CARB-sponsored emission testing conducted by Durbin and others at the University of California CE-CERT[9]. The purpose of the study was "... to evaluate different B5 blends as potential emissions equivalent biodiesel fuel formulations for California."[10] Three B5 blends derived from soy, waste vegetable oil (WVO), and animal biodiesel stocks were tested on one 2006 Cummins ISM 370 engine using the hot-start EPA heavy-duty engine dynamometer cycle. A preliminary round of testing was conducted for all three fuels followed by emissions-equivalent certification testing per 13 CCR 2282(g) for two of the fuels. As noted by Durbin: "[t]he emissions equivalent diesel certification procedure is robust in that it requires at least twenty replicate tests on the reference and candidate fuels, providing the ability to differentiate small differences in emissions."[11]

Soy and WVO B5 Biodiesel

The B5-soy and B5-WVO fuels were blended from biodiesel stocks that were generally similar to the soy-based stock used in the earlier CARB Biodiesel Characterization Study (Durbin 2011) with respect to API gravity and cetane number. In the preliminary testing, the two fuels "...showed 1.2-1.3% statistically significant [NOx emissions] increases with the B5-soy and B5-WVO biodiesel blends compared to the CARB reference fuel."[12] The B5-WVO fuel caused the smaller NOx increase (1.2%) and was selected for the certification phase of the testing. There, it "... showed a statistically significant 1.0% increase in NOx compared to the CARB reference fuel"[13] and failed the emissions-equivalent certification due to NOx emissions.

Animal B5 Biodiesel

The B5-animal derived fuel was blended from an animal tallow derived biodiesel that was substantially different from the animal based biodiesel used in the earlier Durbin study, and was higher in both API gravity and cetane number. The blending response for cetane number was also surprising, in that blending 5 percent by volume of a B100 stock (cetane number 61.1) with 95% of CARB ULSD (cetane number 53.1) produced a B5 fuel blend with cetane number 61.

In preliminary testing, the B5-animal fuel showed a small NOx increase which was not statistically significant, causing it to be judged the best candidate for emissions-equivalent certification. In the certification testing, it "...showed a statistically

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[9] "CARB B5 Biodiesel Preliminary and Certification Testing." Prepared by Thomas D. Durbin, G. Karavalakis and others. Prepared for Alexander Mitchell, California Air Resources Board. July 2013. This study is not referenced in the ISOR, nor was it included in the rule making file when the hearing notice for the ADF regulation was published in October 2013.
[10] Ibid, p. vi.
[11] Ibid, p. viii.
[12] Ibid, p. 8.
[13] Ibid, p. 9.

significant 0.5% reduction in NOx compared to the CARB reference fuel"[13] and passed the emissions-equivalent certification. The NOx emission reduction for this fuel blend appears to be real for this engine, but given the differences between the blendstock and the animal based biodiesel blendstock used in the earlier Durbin study it is unclear that it is representative for animal-based biodiesels in general..

Summary

The conclusions drawn in the preceding section are not changed by the consideration of these new emission testing results. For plant-based biodiesels (soy- and WVO-based), the new testing provides additional and statistically significant evidence that B5 blends will increase NOx emissions at the B5 level. The result of decreased NOx for the B5 animal-based blend stands out from the general trend of research results reviewed in this report. However:

- The same result – reduced NOx emissions for some fuels and engines – has sometimes been observed in past research, as evidenced by the emissions data considered by CARB staff in ISOR Figure B.3 (reproduced in Figure 2.1 below). As shown, some animal-based B5 and B20 fuels reduced NOx emissions while others increased NOx emissions with the overall conclusion being that NOx emissions increase in direct proportion to biodiesel content of the blends and that there is no emissions threshold.

- Increasing cetane is known to generally reduce NOx emissions and has already been proposed by CARB as a mitigation strategy for increased NOx emissions from biodiesel[14]. The unusual cetane number response in the blending and the high cetane number of the B5-animal fuel may account for the results presented in the recently released study.

Considering the broad range of plant- and animal-based biodiesel stocks that will be used in biodiesel fuels, we conclude that the available research (including the recently released CARB test results) indicates that unrestricted biodiesel use at the B5 level will cause real increases in NOx emissions and that countermeasures may be required to prevent increases in NOx emissions due to biodiesel use at blending levels below B10.

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[14] For example, see Durbin 2011 Section 7.0 for a discussion of NOx mitigation results through blending of cetane improvers and other measures.

2. CARB LITERA TURE REVIEW

The Staff ISOR explains that the Appendix B Technology Assessment is the basis for CARB's conclusion that biodiesels below B10 have no significant impact on NOx emissions. The assessment is based on data from seven studies (identified in Table 2-1) that tested high-cetane diesel fuels. The first study (Durbin 2011) is the Biodiesel Characterization Study that was conducted for CARB, while the others were obtained through a literature search.

Tab le 2-1
List of Studies from High-Cetane Liter ature Sear ch

Primary Author	Title	Published	Year
Durbin	Biodiesel Mitigation Study	Final Report Prepared for Robert Okamoto, M.S. and Alexander Mitchell, CARB	2011
Clark	Transient Emissions Comparisons of Alternative Compression Ignition Fuel	SAE 1999-01-1117	1999
Eckerle	Effects of Methyl Ester Biodiesel Blends on NOx Emissions	SAE 2008-01-0078	2008
McCormick	Fuel Additive and Blending Approaches to Reducing NOx Emissions from Biodiesel	SAE 2002-01-1658	2002
McCormick	Regulated Emissions from Biodiesel Tested in Heavy-Duty Engines Meeting 2004 Emissions	SAE 2005-01-2200	2005
Nuszkowski	Evaluation of the NOx emissions from heavy duty diesel engines with the addition of cetane improvers	Proc. I Mech E Vol. 223 Part D: J. Automobile Engineering, 223, 1049-1060	2009
Thompson	Neat fuel influence on biodiesel blend emissions	Int J Engine Res Vol. 11, 61-77.	2010

Source: Table B.2 of Durbin 2011

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Figure 2-1 reproduces two exhibits from Appendix B that show increasing trends for NOx emissions with the biodiesel blending level. Based on the slopes of the trend lines,

Figure 2-1
NOx Emission Increases Observed in Biodiesel Research Cited in Staff ISOR

Figure B.2: NOx Impact of Soy Biodiesel Blended in High Cetane Base Fuel

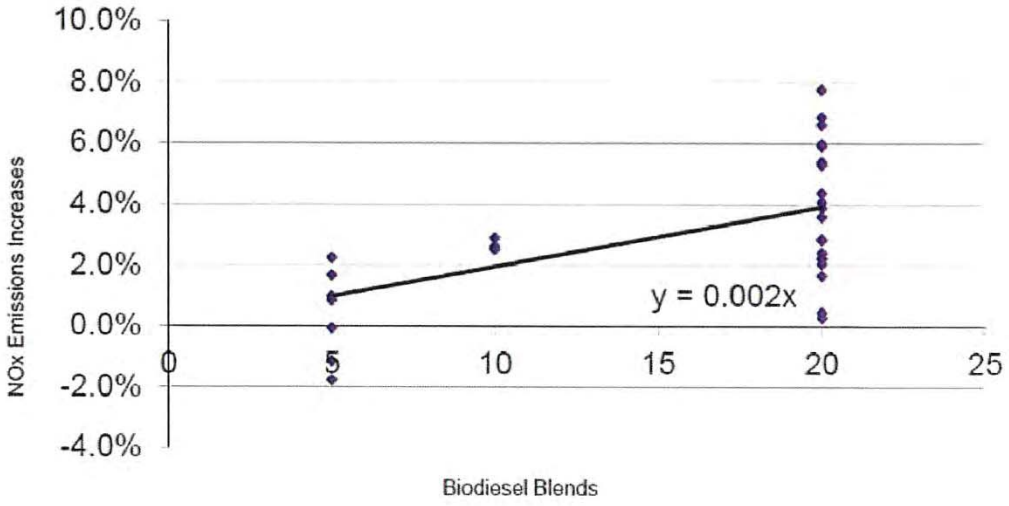
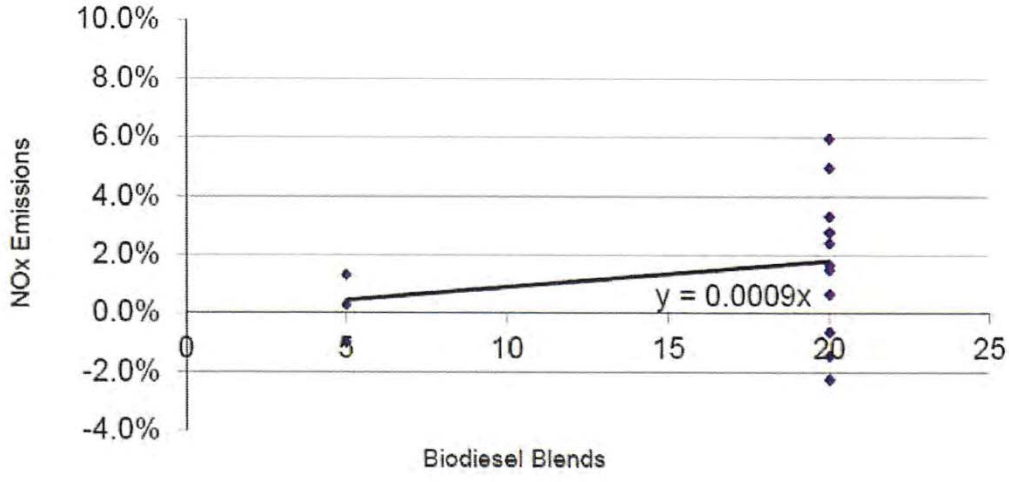


Figure B.3: NOx Impact of Animal Biodiesel Blended in High Cetane Base Fuel



Source: Figures B.2 and B.3 of Appendix B: Technology Assessment

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soy-based biodiesels are shown to increase NOx emissions by approximately 1% at B5, 2% at B10, and 4% at B20. Animal-based biodiesels are shown to increase NOx emissions by about one-half as much: 0.45% at B5, 0.9% at B10, and 1.8% at B20. Although there is substantial scatter in the results, these data do not appear to support the Staff Threshold Model that biodiesel does not increase NOx emissions at B5 but does so at B10.

We will examine the Durbin 2011 study at some length in Section 3. In this section, we look at each of the other studies cited by the Staff to find out what the studies say about NOx emissions impacts at and below B10.

2.1 Review of Literature Cited in the ISOR

The Staff literature search sought and selected testing that used fuels with cetane levels comparable to California diesel fuels; the Staff does not, however, list those fuels or provide the data that support the tables and figures in Appendix B of the ISOR. Therefore, we have necessarily made our own selection of high-cetane fuels in the course of reviewing the studies. The key testing and findings of each study are summarized below, with a specific focus on what they tell us about NOx emission impacts at B10 and below.

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2.1.1 Clark 1999

This study tested a variety of fuels on a 1994 7.3L Navistar T444E engine. Of the high-cetane base fuels, one base fuel (Diesel A, off-road LSD) was blended and tested at levels of B20, B50, and B100. NOx emissions were significantly increased for all of the blends. The other base fuel (CA Diesel) was tested only as a base fuel. Its NOx emissions were 12% below that of Diesel A, making it is unclear whether Diesel A is representative of fuels in CA. This study conducted no testing of the NOx emissions impact from biodiesels at the B10 level or below.

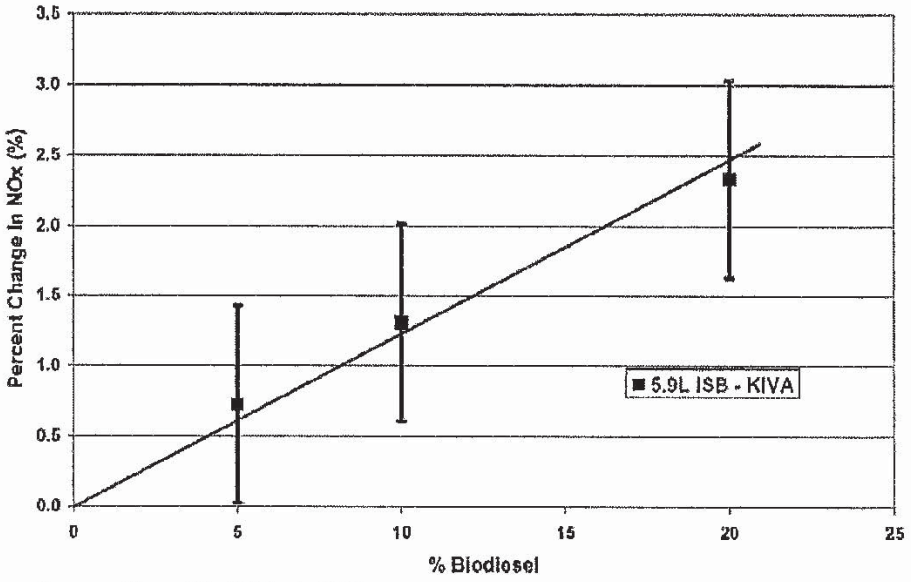
2.1.2 Eckerle 2008

This study tested low and mid/high-cetane base fuels alone and blended with soy-based biodiesel at the B20 level. The Cummins single-cylinder test engine facility was used in a configuration representative of modern diesel technology, including cooled EGR. Testing was conducted under a variety of engine speed and load conditions. FTP cycle emissions were then calculated from the speed/load data points. The test results show that B20 blends increase NOx emissions compared to both low- and high-cetane base fuels. This study conducted no testing of the NOx emissions impact from biodiesels at the B10 level or below.

The study notes that two other studies "show that NOx emissions increase nearly linearly with the increase in the percentage of biodiesel added to diesel fuel." Eckerle's Figure 21 (reproduced below as Figure 2-2) indicates a NOx emissions increase at B5, which is the basis for the statement in the abstract that "Results also show that for biodiesel blends containing less than 20% biodiesel, the NOx impact over the FTP cycle is proportional to

the blend percentage of biodiesel." The authors clearly believe that biodiesel fuels have NOx emission impacts proportional to the blending percent at all levels including B5.

Figure 2-2
Impact of Biodiesel Blends on Percent NOx Change for the 5.9L ISB Engine Operation Over the FTP Cycle



Source: Figure 21 of Eckerle 2008

2.1.3 McCormick 2002

This study tested low- and mid-cetane base fuels alone and blended with soy- and animal-based biodiesel at the B20 level. The testing was conducted on a 1991 DDC Series 60 engine using the hot-start U.S. heavy-duty FTP. NOx emission increases were observed for both fuels at the B20 level. Mitigation of NOx impacts was investigated by blending a Fisher-Tropsch fuel, a 10% aromatics fuel and fuel additives. This study conducted no testing of the NOx emissions impact from commercial biodiesels at the B10 level or below.

This study also tested a Fisher-Tropsch (FT) base fuel blended at the B1, B20, and B80 levels. Although the very high cetane number (≥75) takes it out of the range of commercial diesel fuels, it is interesting to note that the study measured higher NOx emissions at the B1 level than it did on the FT base fuel and substantially higher NOx emissions at the B20 and B80 levels. While the B1 increase was not statistically significant given the uncertainties in the emission measurements (averages of three test runs), it is clear that increased NOx emissions have been observed at very low blending levels.

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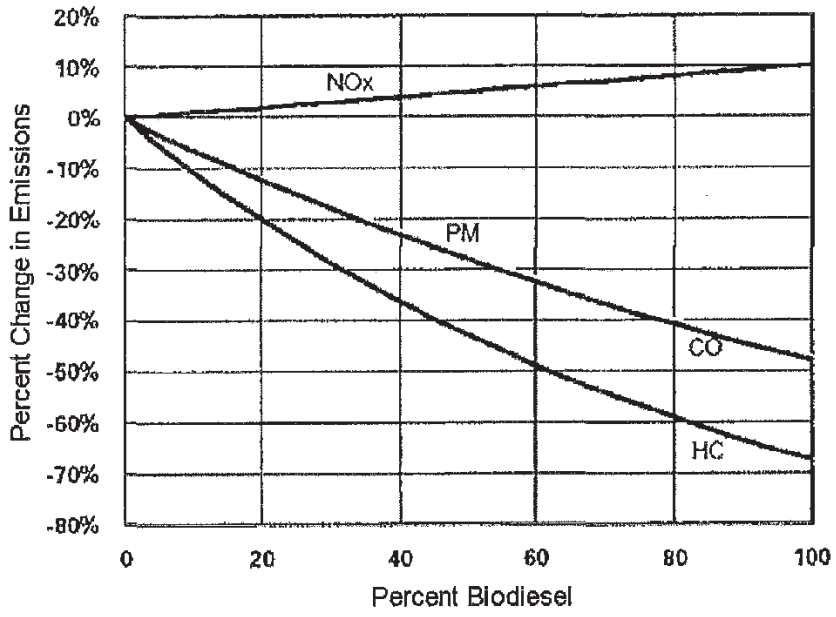
2.1.4 McCormick 2005

This study tested blends of soy- and animal-based biodiesels with a high-cetane ULSD base fuel at B10 levels and higher. Two engines were tested – a 2002 Cummins ISB and a 2003 DDC Series 60, both with cooled EGR. The hot-start U.S. heavy-duty FTP test cycle was used. The majority of testing was at the B20 level with additional testing at the B50 and B100 levels. One soy-based fuel was tested at B10. The study showed NOx emission increases at B10, B20, and higher levels. The study also investigated mitigation of NOx increases. This study conducted no testing of the NOx emissions impact from biodiesels below the B10 level.

The authors present a figure (reproduced as Figure 2-3) in their introduction that shows their summary of biodiesel emission impacts based on an EPA review of heavy-duty engine testing. It shows NOx emissions increasing linearly with the biodiesel blend percentage.

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Figure 2-3
Trend in HC, CO, NOx and PM Emissions with Biodiesel Percent



Source: McCormick 2005

2.1.5 Nuszkowski 2009

This study tested five different diesel engines: one 1991 DDC Series 60, two 1992 DDC Series 60, one 1999 Cummins ISM, and one 2004 Cummins ISM. Only the 2004 Cummins ISM was equipped with EGR. All testing was done using the hot-start U.S. heavy-duty FTP test cycle. The testing was designed to test emissions from fuels with and without cetane-improving additives. Although a total of five engines were tested, the base diesel and B20 fuels were tested on only two engines (one Cummins and one DDC Series 60) because there was a limited supply of fuel available. NOx emissions increased on the B20 fuel for both engines. A third engine (Cummins) was tested on B20 and B20 blended with cetane improvers to examine mitigation of NOx emissions. This study conducted no testing of the NOx emissions impact from biodiesels at the B10 level or below.

2.1.6 Thompson 2010

This study examined the emissions impacts of soy-based biodiesel at the B10 and B20 levels relative to low-cetane (42), mid-cetane (49), and high-cetane (63) base fuels using one 1992 DDC Series 60 engine. The emissions results were measured on the hot-start U.S. heavy-duty FTP cycle. The study found that NOx emissions were unchanged (observed differences were not statistically significant) at B10 and B20 levels for the low- and mid-cetane fuels. NOx emissions increased significantly at B10 and B20 levels for the high-cetane fuels. This study conducted no testing of the NOx emissions impact from biodiesels at levels below B10.

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2.2 Conclusions Based on Studies Obtained in Literature Search

From the foregoing summary of the studies cited by Staff, we reach the conclusions given below.

1. None of the six studies measured the NOx emissions impact from commercial-grade biodiesel at blending levels below B10, and only two studies tested a fuel at the B10 level. All other testing was at the B20 level or higher. Because none tested a B5 (or similar) fuel, none is capable of providing direct evidence regarding NOx emissions at B5 or other blending levels below B10.

2. These studies provide no data or evidence supporting the validity of Staff's Threshold Model that biodiesel below B10 does not increase NOx emissions. In fact, all of the studies are consistent with the contention that biodiesel increases NOx emissions in proportion to the blending percent.

3. Two of the studies present evidence and arguments that the NOx impact from biodiesel is a continuous effect that is present even at very low blending levels and will increase at higher levels in proportion to the blending percentage. One study tested a Fischer-Tropsch biodiesel blend at B1 and observed NOx emissions to increase (but not by a statistically significant amount).

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3. CARB BIODIESEL CHARACTERIZATION STUDY

3.1 Background

CARB sponsored a comprehensive study of biodiesel and other alternative diesel blends in order "... to better characterize the emissions impacts of renewable fuels under a variety of conditions."[15] The study was designed to test eight different heavy- duty engines or vehicles, including both highway and off-road engines using engine or chassis dynamometer testing. Five different test cycles were used: the Urban Dynamometer Driving Schedule (UDDS), the Federal Test Procedure (FTP), and 40 mph and 50 mph CARB heavy-heavy-duty diesel truck (HHDDT) cruise cycles, and the ISO 8178 (8 mode) cycle. Table 3-1 (reproduced from Table ES-1 of Durbin 2011) documents the scope of the test program. Because the Staff relied only on engine dynamometer testing in its Technology Assessment, only the data for the first four engines (shaded) are considered here.

Table 3-1
A Breakdown of the Test Engines for the Different Categories of Testing

2006 Cummins ISM[a]	Heavy-duty on-highway	Engine dynamometer	
2007 MBE4000	Heavy-duty on-highway	Engine dynamometer	
1998, 2.2 liter, Kubota V2203-DIB	Off-road	Engine dynamometer	
2009 John Deere 4.5 L	Off-road	Engine dynamometer	
2000 Caterpillar C-15	Heavy-duty on-highway	Chassis dynamometer	Freightliner chassis
2006 Cummins ISM	Heavy-duty on-highway	Chassis dynamometer	International chassis
2007 BME4000	Heavy-duty on-highway	Chassis dynamometer	Freightliner chassis
2010 Cummins ISX15	Heavy-duty on-highway	Chassis dynamometer	Kenworth chassis

Source: Table ES-1 of Durbin 2011, page xxvi
Notes:
[a] Data for the first four engines (shaded) are considered in this report.

[15] Durbin 2011, p. xxiv.

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The original goal of this report was to subject all of the NOx emission testing in Durbin 2011 to a fresh re-analysis. However, it was discovered that Durbin 2011 did not report all of the data that were obtained during the program and are discussed in the report. The chassis dynamometer testing was conducted at the CARB Los Angeles facility. Emission results for the chassis dynamometer testing are presented in tabular and graphical form, but the report does not contain the actual emissions test data. For the engine dynamometer testing, some of the measured emission values are not reported even though the emission results are reported in tabulated or graphical form. Requests for the missing data were directed to Durbin in a personal request and to CARB through an official records request. No information has been provided in response and we have not been able to obtain the missing data from online or other sources.

For this report, we have worked with the data in the forms that are provided in Durbin 2011 as being the best-available record of the results of the CARB study. Because Staff used only data obtained in engine dynamometer testing, the analysis presented in this report has done the same. Nevertheless, the results of the chassis dynamometer testing are generally supportive of the results and conclusions presented here. Durbin 2011 notes:

> "... The NOx emissions showed a consistent trend of increasing emissions with increasing biodiesel blend level. These differences were statistically significant or marginally significant for nearly all of the test sequences for the B50 and B100 fuels, and for a subset of the tests on the B20 blends."[16]

Durbin notes that emissions variability was greater in the chassis dynamometer testing, which leads to the sometimes lower levels of statistical significance. There was also a noticeable drift over time in NOx emissions that complicated the results for one engine.

3.2 Data and Methodology

Table 3-2 compiles descriptive information on the engine dynamometer testing performed in Durbin 2011. The experimental matrix involves four engines, two types of biodiesel fuels (soy- and animal-based), and up to four test cycles per engine. However, the matrix is not completely filled with all fuels tested on all engines on all applicable test cycles. The most complete testing is for the ULSD base fuel and B20, B50, and B100 blends. There is less testing for the B5 blend, and B5 is tested using only a subset of cycles. For this reason, we first examine the testing for ULSD, B20, B50, and B100 fuels to determine the overall impact of biodiesels on NOx emissions. We then examine the more limited testing for B5 to determine the extent to which it impacts NOx emissions.

This examination is limited by the form in which emissions test information is reported in Durbin 2011. A complete statistical analysis can be conducted only for the two on-road engines for which Appendices G and H of Durbin 2011 provide measured emissions, and for a portion of the testing of the Kubota off-road engine for which Appendix I provides

[16] Durbin 2011, p. 126.

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Table 3-2
Experimental Matrix for Heavy-Duty Engine Dynamometer Testing Reported in Durbin 2011

Engine	Biodiesel Type	Fuels Tested	Test Cycles	Notes
On-Road Engines				
2006 Cummins ISM	Soy	ULSD, B20, B50, B100, B5	UDDS, FTP, 40 mph, 50 mph	B5 tested on 40 mph and 50 mph cruise cycles
	Animal	ULSD, B20, B50, B100, B5	UDDS, FTP, 50 mph	B5 tested only on FTP.
2007 MBE4000	Soy	ULSD, B20, B50, B100, B5	UDDS, FTP, 50 mph	B5 tested only on FTP.
	Animal	ULSD, B20, B50, B100, B5		B5 tested only on FTP.
Off-Road Engines				
1998 Kubota V2203-DIB	Soy	ULSD, B20, B50, B100, B5	ISO 8178 (8 Mode)	none
	Animal	Not tested		
2009 John Deere	Soy	ULSD, B20, B50, B100	ISO 8178 (8 Mode)	B5 not tested
	Animal	ULSD, B20, B5		none

measured emissions. The data needed to support a full re-analysis consist of measured emissions on each fuel in gm/hp-hr terms, which are stated in Durbin 2011 as averages across all test replications along with the number of replications and the standard error of the individual tests. With this information, the dependence of NOx emissions on biodiesel blending percent can be determined as accurately as if the individual test values had been reported and the appropriate statistical tests for the significance of results can be performed.

Regression analysis is used as the primary method of analysis. For each engine and test cycle, the emission averages for each fuel are regressed against the biodiesel blending percent to determine a straight line. The regression weights each data point in inverse proportion to the square of its standard error to account for differences in the number and reliability of emission measurements that make up each average. The resulting regression line will pass through the mean value estimated from the data (i.e., the average NOx emission level at the average blending percent), while the emission averages for each fuel may scatter above and below the regression line due to uncertainties in their measurement. The slope of the line estimates the dependence of NOx emissions on the blending percentage.

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Where the data points closely follow a straight line and the slope is determined to be statistically significant, one can conclude that blending biodiesel with a base fuel will increase NOx emissions in proportion to the blending percent. The regression line can then be used to estimate the predicted emissions increase for a given blending percent. The predicted emissions increase is the value one would expect on average over many measurements and is comparable to the average emissions increase one would expect in a fleet of vehicles.

The same level of analysis is not possible for the testing on B5 fuel, which is reported as a simple average for the on-road engines and is not reported at all for the off-road engines. For the B5 fuel, Durbin 2011 presents emission test results in a tabulated form where the percentage change in NOx emissions has been computed compared to ULSD base fuel. This form supports the presentation of results graphically, but it does not permit a proper statistical analysis to be performed. Specifically, the computation of percentage emission changes will perturb the error distribution of the data, by mixing the uncertainty in measured emissions on the base fuel with the uncertainties in measured emissions on each biodiesel blend, and it can introduce bias as a result of the mixing. Further statistical analysis of the computed percent values should be avoided because of these problems. Therefore, a more limited trend analysis of the NOx emissions data for B5 and the John Deere engine is conducted.

3.3 2006 Cummins Engine (Engine Dynamometer Testing)

Table 3-3 shows the NOx emission results for the 2006 model-year Cummins heavy-duty diesel engine based on a re-analysis of the data for this report. As indicated by highlighting in the table, the relationship between increasing biodiesel content and increased NOx emissions for soy-based biodiesel is statistically significant at >95% confidence level[17] in all cases. For the animal-based biodiesel, the relationship is statistically significant at the 92% confidence level for the UDDS cycle, the 94% confidence level for the 50 mph cruise, and the >99% confidence level for the FTP cycle.

For the soy-based fuels, the R^2 statistics show that the emissions effect of biodiesel is almost perfectly linear with increasing biodiesel content over the range B20, B50, and B100. Although not as high for the animal-based fuels (because the emissions effect is smaller and measurement errors are relatively larger in comparison to the trend), the R^2 statistics nevertheless establish a linear increase in NOx emissions with increasing biodiesel content over the same range. The linearity of the response with blending percent is well supported by the many NOx emissions graphs contained in Durbin 2011.

The table also gives the estimated NOx emission increases for B5 and B10 as predicted by the regression lines. For soy-based fuels, the values are 1% for B5 (range 0.8% to 1.3% depending on the cycle) and 2% for B10 (range 1.6% to 2.6% depending on cycle).

[17] A result is said to be statistically significant at the 95% confidence level when the p value is reported as $p \leq 0.05$. At the $p \leq 0.01$ level, a result is said to be statistically significant at the 99% confidence level, and so forth.

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Table 3-3 Re-Analysis for 2006 Cummins Engine (Engine Dynamometer Testing) Model: NOx = A + B · BioPct Using ULSD, B20, B50, and B100 fuels							
Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	Pct Change	Pct Change
Soy-based							
	UDDS	0.997	5.896	0.0100 [a]	0.001	0.8%	1.7%
	FTP	0.995	2.024	0.0052	0.003	1.3%	2.6%
	40 mph	1.000	2.030	0.0037	<0.0001	0.9%	1.8%
	50 mph	0.969	1.733	0.0028	0.016	0.8%	1.6%
Animal-based							
	UDDS	0.847	5.911	0.0021 [b]	0.080	0.2%	0.4%
	FTP	0.981	2.067	0.0031	0.001	0.7%	1.4%
	50 mph	0.887	1.768	0.0011	0.058	0.3%	0.6%

Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better.
[b] Orange highlight indicates result is statistically significant at the 90% confidence level or better.

For animal-based fuels, the values are approximately one-half as large: 0.4% for B5 (range 0.2% to 0.7%) and 0.8% for B10 (range 0.4% to 1.4%). These predicted increases are statistically significant to the same degree as the slope of the regression line from which they are estimated. That is, the NOx increases predicted by the regression line for soy-based fuels are statistically significant at the 95% confidence level (or better) on all cycles and the predicted NOx increases for animal-based fuels are statistically significant at the 90% confidence level (or better) on all cycles and at the >99% confidence level for the FTP.

Because the limited data on B5 were not used to develop the regression lines for each cycle, and no test data on B10 are available, use of the lines to make predictions for B5 and B10 depends on their linearity over the range between ULSD and B20. Based on the R^2 statistics and the graphs in Durbin 2011, the slopes observed between ULSD and B20 are the same as the slopes observed between B20 and B100 for each of the test cycles. We believe that the linearity of the response with blending percent for values over the range ULSD to B100 would be accepted by the large majority of researchers in the field, as would the use of regression analysis to make predictions for B5 and B10.

The Durbin 2011 report takes a different approach for determining the statistical significance of NOx emission increases for each fuel. For each fuel tested, it computes a percentage change in emissions for NOx (and other pollutants) relative to the ULSD base fuel. It then determines the statistical significance of each observed change using a conventional t-test for the difference of two mean values (2-tailed, 2 sample equal

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variance t-test). The t-test is conducted on the measured emission values before the percentage emission change is computed.

The t-test would be the appropriate approach for determining statistical significance if only two fuels were tested. However, it is a simplistic approach when three or more fuels are tested because it is applied on a pair-wise basis (B5 vs. ULSD, B20 vs. ULSD, etc.) and does not make use of all of the data that is available. It will have less power than the regression approach to detect emission changes that are real. This limitation is in one direction, however, in that the test is too weak when 3 or more data points are available, but a finding of statistical significance is valid when it occurs. As long as the linear hypothesis is valid, the regression approach should be the preferred method for analysis and for the determination of whether biodiesel blending significantly increases NOx emissions.

Because emission changes will be smallest for B5 (because of the low blending volume), the pair-wise t-test is most likely to fail to find statistical significance at the B5 level. In cases where the pair-wise t-test for B5 says that the emission change vs. ULSD is not statistically significant – but slope of the regression line is statistically significant – the proper conclusion is that additional B5 testing (to improve the precision of the emission averages) would likely lead to the detection of a statistically significant B5 emissions change using the t-test. In this case, the failure to find statistical significance using the t-test is not evidence that B5 does not increase NOx emissions.

For this engine, soy-based B5 was tested on the 40 mph and 50 mph cruise cycles and animal-based B5 was tested on the FTP. To examine this matter further, Table 3-4 reproduces NOx emission results reported in Tables ES-2 and ES-3 of Durbin 2011. Soy-based B5 was shown to increase NOx emissions on the 40 mph cruise cycle, but not on the 50 mph cruise cycle. Animal-based B5 was shown to increase NOx emissions on the FTP. Durbin 2011 noted (p. xxxii) that "[t]he 50 mph cruise results were obscured, however, by changes in the engine operation and control strategy that occurred over a segment of this cycle." Therefore, we discount the 50 mph cruise results and do not consider them further. Neither of the remaining B5 NOx emission increases (for the 40 mph Cruise and FTP cycles) were found to be statistically significant using the t-test, although the 40 mph cruise result for soy-based fuels comes close to being marginally significant (it would be statistically significant at an 86.5% level). The NOx emission increases at higher blending levels were found have high statistical significance (>99% confidence level).

This format, used throughout Durbin 2011 to report emission test data and to show the effect of biodiesel on emissions, is subject to an important statistical caveat. The percent changes are computed by dividing the biodiesel emission values by the emissions measured for the ULSD base fuel. Therefore, measurement errors in the ULSD measurement are blended with the measurement errors for each of the biodiesel fuels. The blending of errors in each computed percent change can bias the apparent trend of emissions with increasing biodiesel content. As will be shown in Section 3.3.2, we can see this problem in the animal-based B5 test data for this engine.

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Table 3-4 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 2006 Cummins Engine (Engine Dynamometer Testing)						
	Soy-based Biodiesel				Animal-based Biodiesel	
	40 mph Cruise		50 mph Cruise		FTP	
	NOx % Diff	p value	NOx % Diff	p value	NOx % Diff	p value
B5	1.7%	0.135	-1.1%	0.588	0.3%	0.298
B20	3.9%[a]	0.000	0.5%	0.800	1.5%	0.000
B50	9.1%	0.000	6.3%	0.001	6.4%	0.000
B100	20.9%	0.000	18.3%	0.000	14.1%	0.000

Source: Table ES-2 and ES-3 of Durbin 2011, p. xxviii
Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on the pair-wise t-test.

3.3.1 NOx Impact of Soy-based Biodiesel at the B5 Level

Figures 3-1a and 3-1b display the trend of NOx emissions with blending percent for the soy-based biodiesel on the 40 mph cruise cycle. Figure 3-1a plots the percentage increases as reported by Durbin 2011 in contrast to two different analytical models for the relationship:

- The Linear Model shown by the blue line; and
- The Staff Threshold model (black line), in which the NOx emission change is zero through B9 and then increases abruptly to join the linear model.

In Figure 3-1a, the linear model is an Excel trendline for the computed percent changes. While the data violate a key assumption for the proper use of regression analysis, this approach is the only way to establish a trendline given the form in which Durbin 2011 tabulates the data and presents the results of its testing.

Figure 3-1b plots the actual measured emission values in g/bhp-hr terms in contrast to the same two analytical models. Here, the linear model line is determined through a proper use of regression analysis, in which each emission average in g/bhp-hr terms is weighted inversely by the square of its standard error, using the data for ULSD, B20, B50 and B100 (i.e., excluding the B5 data point). In the case of this engine and biodiesel fuel, both forms of assessment show generally the same trend for NOx emissions as a function of blending percent. Although the NOx emission increases for B5 may fail the t-test for significance, emissions are increased at B5 and the B5 data point is fully consistent with the Linear Model. The Threshold model is clearly a less-satisfactory representation of the test data.

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Figure 3-1a
Durbin 2011 Assessment: 40 mph Cruise Cycle NOx Emissions Increases for Soy-Biodiesel Blends (2006 Cummins Engine)

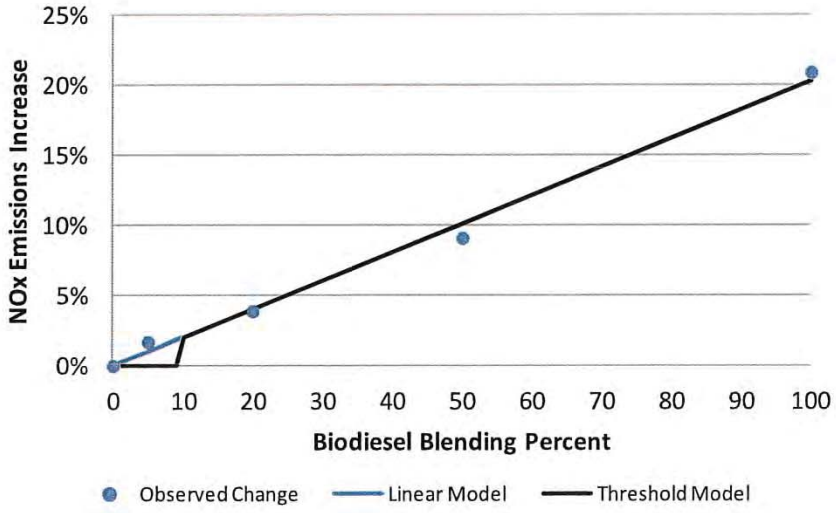
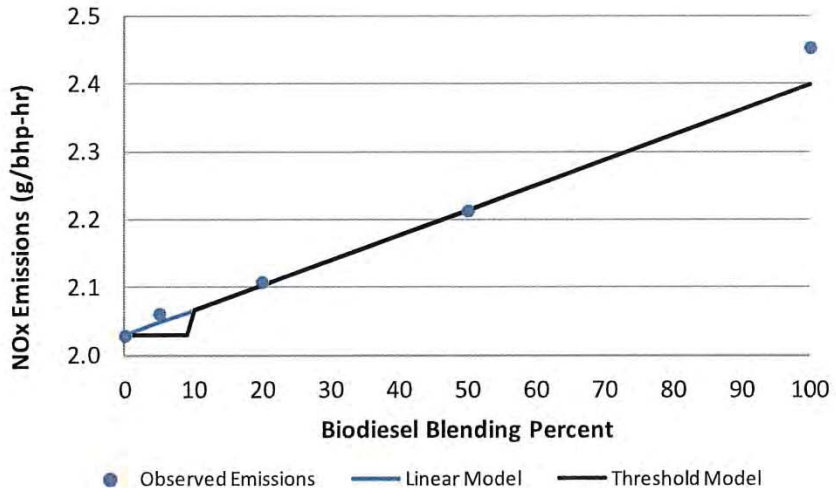


Figure 3-1b
Re-assessment of 40 mph Cruise Cycle NOx Emissions Increases for Soy-Biodiesel Blends (2006 Cummins Engine)



Note that the slope of the trendline (Figure 3-1a) is greater than the slope of the regression line (Figure 3-1b). In the latter figure, the B100 data point stands above the regression line, which passes below it. The regression line (but not the trendline) is fit in

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a manner that accounts for the uncertainties in each data point, so that the line will pass closer to points that have smaller uncertainties and farther from points that have greater uncertainties. For these data, the B100 data point has the largest uncertainty (±0.026 g/bhp-hr) followed by the B20 data point (±0.025 g/bhp-hr). The other three data points (ULSD, B5, and B50) have uncertainties less than ±0.001 g/bhp-hr. The B20 data point happens to fall on the line, but the B100 data point is found to diverge above. Because the regression analysis can account for the relative uncertainties of the data points, it provides a more accurate and reliable assessment of the impact on NOx emissions.

3.3.2 NOx Impact of Animal-based Biodiesel at the B5 level

Figures 3-2a and 3-2b display the trend of NOx emissions with blending percent for the animal-based biodiesel on the FTP test cycle as reported by Durbin 2011 and as re-assessed in this report using regression analysis, respectively. As Figure 3-2a shows, the NOx percent change values reported by Durbin 2011 appear to follow the Staff Threshold model in that NOx emissions are not materially increased at B5, but are increased significantly at B20 and above. As a result, the blue trendline in the figure (fit from the B20, B50 and B100 data points) has a negative intercept.

Figure 3-2b paints a very different picture from the data. Here, the ULSD and B5 data points stand above the weighted regression line (blue) developed from the data for ULSD, B20, B50 and B100. In the data used to fit the regression line, the ULSD data point has the largest uncertainty (±0.013 g/bhp-hr) while the other three data points (B20, B50, and B100) have uncertainties of ±0.002 g/bhp-hr (one case) and ±0.001 g/bhp-hr (two cases). Considering all of the data, the B5 data point has the second highest uncertainty (±0.007 g/bhp-hr). The regression line closely follows a linear model with a high R^2 (0.981) considering the weighted errors, while the ULSD and B5 points lie above it.

Because the ULSD data point is subject to more uncertainty and appears to be biased high compared to the regression line, the NOx percent changes computed by Durbin 2011 are themselves biased. The trendline result in Figure 3-2a that appeared to be supportive of the Staff Threshold model now appears to be the result of biases in the ULSD and B5 emission averages.

Two important conclusions can be drawn from the foregoing:

1. Accurate and reliable conclusions regarding the impact of B5 on NOx emissions cannot be drawn from the computed percent changes that are reported in Durbin 2011. Nor can accurate and reliable conclusions be drawn from visual inspection of graphs that present such data. Weighted regression analysis of the measured emission values (g/bhp-hr terms) must be performed so that the uncertainties in emissions measurements can be fully accounted for.

2. When a weighted regression analysis is performed using the testing for this engine, there is no evidence that supports the conclusion that B5 blends will not increase NOx emissions. In fact, the data are consistent with the conclusion that biodiesel increases NOx emissions in proportion to the blending percent.

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Figure 3-2a
Durbin 2011 Assessment: FTP NOx Emissions Increases for Animal-based Biodiesel Blends (2006 Cummins Engine)

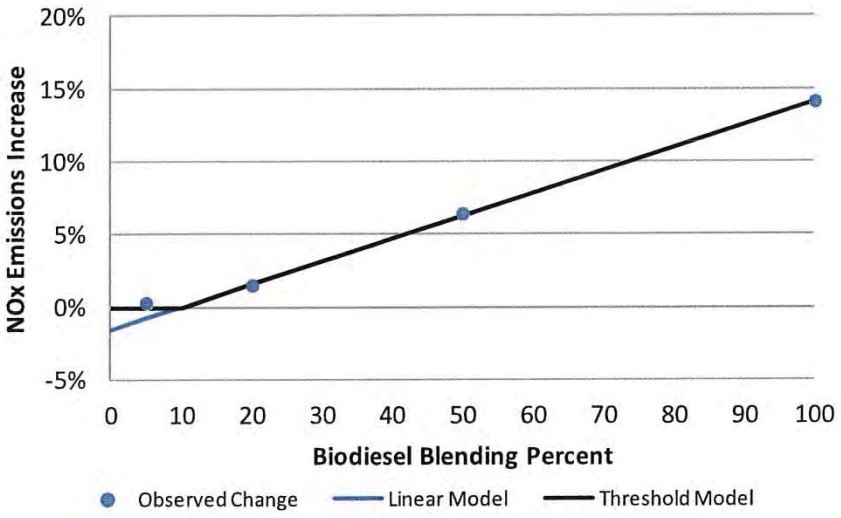
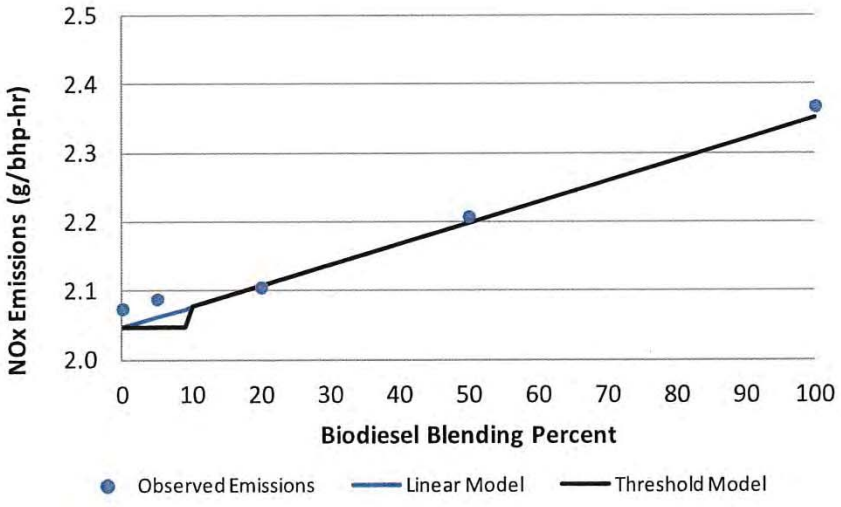


Figure 3-2b
Re-assessment of FTP NOx Emissions Increases for Animal-based Biodiesel Blends (2006 Cummins Engine)



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3.4 2007 MBE4000 Engine (Engine Dynamometer Testing)

To analyze the data for the 2007 MBE4000 engine, it has proved necessary to remove two data points, one for the soy-based B20 fuel on the 50 mpg cruise cycle and one for the animal-based B50 fuel on the FTP test cycle:

- Appendix H reports the 50 mph cruise emission average for soy-based B20 to be 0.014 ± 0.020 g/bhp-hr. This value is implausible and wholly inconsistent with the NOx emission change of +6.9% reported in Table ES-4 of Durbin 2011, which would imply a NOx emission average of 1.21*1.069 = 1.30 g/bhp-hr.

- Appendix H reports the FTP emission average for the animal-based B50 fuel to be 2.592 ± 0.028 g/bhp-hr, which stands well above the other test data on animal-based biodiesel. This value is also inconsistent with the NOx emission change of +12.1% reported in Table ES-4 of Durbin 2011, which would imply a NOx emission average of 1.29*1.121 = 1.45 g/bhp-hr.

We believe these reported values are affected by typographical errors and have deleted them from the dataset used here.

With these corrections, Table 3-5 shows the results of the NOx emissions analysis for the 2007 model-year MBE4000 heavy-duty diesel engine. As indicated by highlighting in the table, the relationship between increasing biodiesel content and increased NOx emissions is statistically significant at >99% confidence level in two cases for soy-based biodiesel (the UDDS and FTP cycles) and at the 90% confidence level in one case (the 50 mph cycle). For the animal-based biodiesel, the relationship is statistically significant at the 96% confidence level for the UDDS cycle, the 98% confidence level for the FTP cycle, and >99% confidence level for the 50 mph cycle.

Durbin 2011 again notes a problem with the 50 mph cruise test results, saying (p. xxxii) that "[the NOx] trend was obscured, however, by the differences in engine operation that were observed for the 50 mph cruise cycle." Therefore, we will focus the discussion on the UDDS and FTP results.

For the soy-based fuels, the R^2 statistics show that the emissions effect of biodiesel is almost perfectly linear with increasing biodiesel content over the range from ULSD to B20, B50, and B100 for all cycles (including the 50 mph cruise). That is, the NOx emissions increase between ULSD and B20 shares the same slope as the NOx emissions increase between B20 and B100. For the animal-based biodiesel, the R^2 statistics also establish a linear increase in NOx emissions with increasing biodiesel content over the same range. The linearity of the response with blending percent is also well supported by the many NOx emissions graphs contained in Durbin 2011.

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Tab le 3-5 Re-Analysis for 2007 MBE4000 En gine (En gine Dynam ometer Testing) Model: NOx = A + B · BioPct Using ULSD, B20, B50, and B100 fuels							
Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	Pct Change	Pct Change
Soy-based							
	UDDS	0.989	2.319	0.0090 [a]	0.005	4.6%	9.1%
	FTP	0.998	1.268	0.0049	0.006	2.5%	5.0%
	50 mph	0.979	1.198	0.0054 [b]	0.092	2.7%	5.5%
Animal-based							
	UDDS	0.913	2.441	0.0036	0.044	2.0%	4.0%
	FTP	0.999	1.288	0.0038	0.020	2.5%	5.0%
	50 mph	0.994	1.205	0.0049	0.003	2.5%	5.0%

Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better.
[b] Orange highlight indicates result is statistically significant at the 90% confidence level or better.

The table also gives the estimated NOx emission increases for B5 and B10 as predicted by the regression lines. For soy-based fuels, the values are ~3.5% for B5 (range 2.5% to 4.6% depending on the cycle) and ~7.5% for B10 (range 5.0% to 9.1% depending on cycle). For animal-based fuels, the values are approximately two-thirds as large: ~2.3% for B5 (range 2.0% to 2.5%) and ~4.5% for B10 (range 4.0% to 5.0%). The predicted increases are statistically significant to the same degree as the slope of the regression line from which they are estimated. That is, the predicted NOx increases are statistically significant at the >99% confidence level for soy-based fuels on the UDDS and FTP cycles and at the >95% confidence level for animal-based fuels on all cycles. The predicted NOx increase is statistically significant at the 90% confidence level for soy-based fuels on the 50 mph cruise cycle.

For this engine, soy- and animal-based B5 were tested on the FTP. Table 3-6 reproduces the NOx emission results reported in Tables ES-4 and ES-5 of Durbin 2011. While there are caveats on use of the pair-wise t-test, the FTP test data for this engine show NOx emissions at the B5 level for both soy- and animal-based fuels that are statistically significant at the 99% confidence level (or better) in this case. That is, the test data for this engine as reported by Durbin 2011 refute the Staff Threshold Model that biodiesel blends below B10 do not increase NOx emissions.

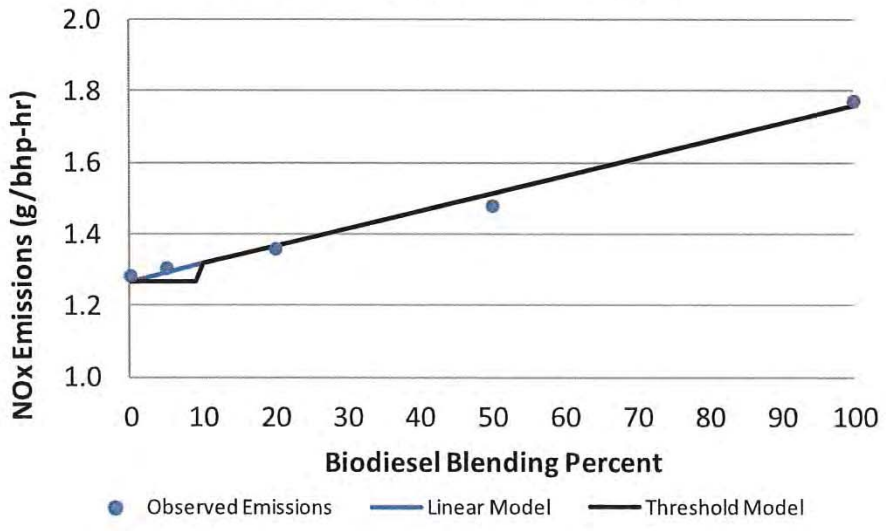
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Table 3-6 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 2007 MBE4000 Engine (Engine Dynamometer Testing)				
	Soy-Based Biodiesel FTP		Animal-Based Biodiesel FTP	
	NOx % Diff	p value	NOx % Diff	p value
B5	0.9% [a]	0.007	1.3%	0.000
B20	5.9%	0.000	5%	0.000
B50	15.3%	0.000	12.1	0.000
B100	38.1%	0.000	29%	0.000

Source: Table ES-4/5 of Durbin 2011, p. xxix
Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on pair-wise t-test.

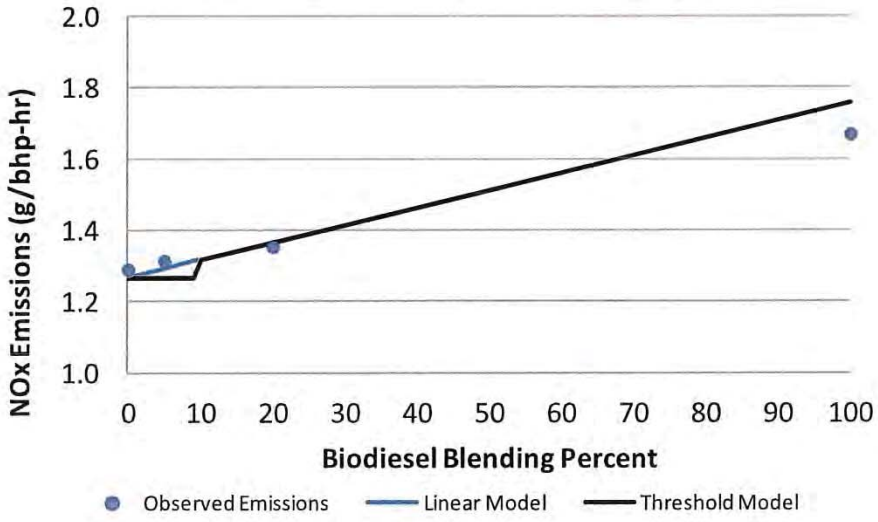
Figures 3-3a and 3-3b below compare the FTP data for this engine to the regression line representing the linear model (blue) and the Staff Threshold model (black) for both soy- and animal-based biodiesel. In both cases, the regression line was developed using the data for ULSD, B20, B50, and B100 (i.e., excluding the B5 data point). For both soy- and animal-based biodiesels, the data point for B5 falls on the established line, while the Staff Threshold model is inconsistent with the data. For this engine, it is clear that soy- and animal-based biodiesels increase NOx emissions at all blending levels.

Figure 3-3a
Re-assessment of FTP Cycle NOx Emissions Increases for Soy-based Biodiesel Blends (2007 MBE4000 Engine)



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Figure 3-3b
Re-assessment of FTP Cycle NOx Emissions Increases for Animal-based Biodiesel Blends (2007 MBE4000 Engine)



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3.5 1998 Kubota TRU Engine (Engine Dynamometer Testing)

The 1998 Kubota V2203-DIB off-road engine was tested on the base fuel (ULSD) and soy-based biodiesel at four blending levels (B5, B20, B50, B100) in two different series using the ISO 8178 (8-mode) test cycle. Appendix I reports the measured emissions data only for the first series (ULSD, B50, B100). Using this subset of data, Table 3-7 summarizes the results of the re-analysis for this engine.

As for the other engines, the results of the analysis demonstrate the following:

- The high R^2 statistic shows that the emissions effect of biodiesel is almost perfectly linear over the range B50 and B100. That is, the slope from ULSD to B50 is the same as the slope from B50 to B100. The slope of the regression line is statistically significant at the 99% confidence level.

- NOx emissions are estimated to increase by 1.0% at the B5 level and by 2.1% at the B10 level. These estimated NOx emission increases are statistically significant to the same high degree as the regression slope on which they are based.

Table 3-7 Re-Analysis for 1998 Kubota V2203-DIB Engine (Engine Dynamometer Testing) Model: NOx = A + B · BioPct Using ULSD, B50, and B100 fuels							
Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	Pct Change	Pct Change
Soy-based	ISO 8178	0.999	12.19	0.0256 [a]	0.01	1.0%	2.1%

Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better.

The second test series involved ULSD, B5, B20, and B100 fuels. Measured emissions data are not given in Appendix I, so we must work with the calculated percent changes in NOx emissions tabulated in Durbin 2011. Table 3-8 reproduces the NOx emission results reported in Table ES-8 of Durbin 2011 for the two test series. For the second test series, biodiesel at the B5 level increased NOx emissions, but the result fails the pair-wise t-test for statistical significance. The NOx emission increase at the B20 level was statistically significant at the 90% confidence level, and the increase at the B100 level was statistically significant at the >99% confidence level. The significance determinations use the pair-wise t-test, which is subject to caveats, but this is the only method available to gauge significance because re-analysis of the computed percentage changes is not possible.

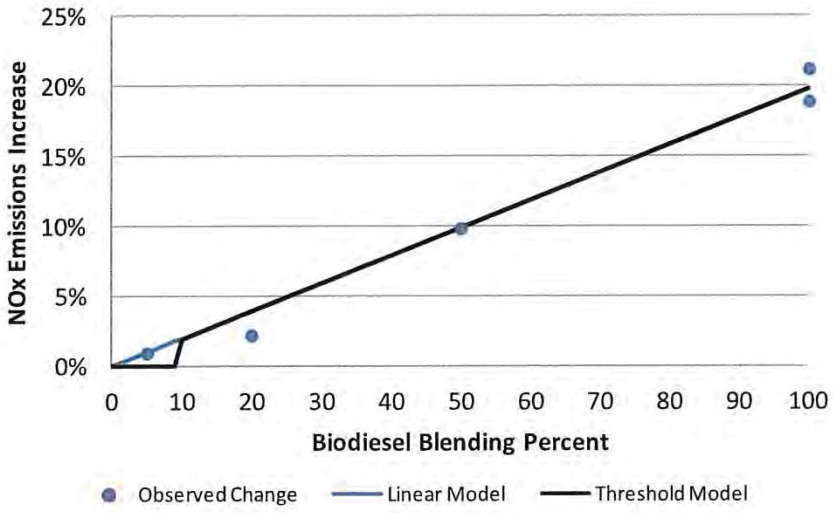
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Table 3-8 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 1998 Kubota TRU Engine (Engine Dynamometer Testing)				
	Soy-Based Biodiesel Series 1 ISO 8178		Soy-Based Biodiesel Series 2 ISO 8178	
	NOx % Diff	p value	NOx % Diff	p value
B5	Not tested		0.97%	0.412
B20	Not tested		2.25% [a]	0.086
B50	7.63% [b]	0.000	Not tested	
B100	13.76%	0.000	18.89%	0.000

Source: Table ES-8 of Durbin 2011, p. xxxviii
Notes:
[a] Orange highlight indicates result is statistically significant at the 90% confidence level or better based on pair-wise t-test.
[b] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on pair-wise t-test

Figure 3-4 displays the trend of NOx emissions with blending percent for the first and second test series combined. As the figure shows, the available data points scatter around the trendline determined from the emission change percentages (not from regression analysis). The B20 data point falls below the trend line while the two B100 data points bracket the trend line. It is not possible to explain the divergence of the B20 data point

Figure 3-4
Durbin 2011 Assessment: ISO 8178 Cycle NOx Emissions Increases for Soy-based Biodiesel Blends (1998 Kubota Engine, Test Series 1 and 2 Combined)



because the emissions data for the second test series are not published in Durbin 2011. The B5 data point clearly supports the Linear Model and is inconsistent with the Staff Threshold Model.

3.6 2009 John Deere Off-Road Engine (Engine Dynamometer Testing)

The only information on the 2009 John Deere off-road engine comes from the tabulation of calculated percentage emission changes. Table 3-9 reproduces these data from Table ES-7 of Durbin 2011. For the soy-based biodiesel, NOx emissions are significantly increased at the B20 and higher blend levels. The increase for B20 is statistically significant at the 90% confidence level and the increases for B50 and B100 are statistically significant at the >99% confidence level based on the pair-wise t-test. A soy-based B5 fuel was not tested.

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Table 3-9 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 2009 John Deere Engine (Engine Dynamometer Testing)				
	Soy-Based Biodiesel ISO 8178		Animal-Based Biodiesel ISO 8178	
	NOx % Diff	p value	NOx % Diff	p value
B5	Not tested		-3.82	0.318
B20	2.82%[a]	0.021	-2.20	0.528
B50	7.63%	0.000	Not tested	
B100	13.76%	0.000	4.57	0.000

Source: Table ES-7 of Durbin 2011, p. xxxviii
Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on pair-wise t-test.

For animal-based biodiesel, the testing shows the unusual result that B5 and B20 appear to decrease NOx emissions, while B100 increases NOx. The B5 and B20 decreases are not statistically significant, while the B100 increase is statistically significant at the >99% confidence level. Durbin 2011 concludes:

> The animal-based biodiesel also did not show as great a tendency to increase NOx emissions compared to the soy-based biodiesel for the John Deere engine, with only the B100 animal-based biodiesel showing statistically significant increases in NOx emissions.[18]

Durbin 2011 does not discuss these results further and does not note any problems in the testing, making further interpretation of the results difficult. Figure 8-1 of Durbin 2011 presents the NOx results for this engine with error bars. First, we note that the figure appears to suggest that NOx emissions were increased on the B20 fuel in contradiction to the table above. Second, it is clear that the error bars are large enough that no difference in NOx emissions can be detected among ULSD, B5, and B20 fuels. Overall, this result could be consistent with the Staff Threshold Model through B5, but the failure to detect a NOx emission increase at B20 is not. Without further information, it is not possible to determine whether the result seen here is a unique response of the John Deere engine to animal-based biodiesel or is the result of a statistical fluctuation or an artifact in the emissions data.

3.7 Conclusions

The Biodiesel Characterization report prepared by Durbin et al. for CARB is an important source of information on the NOx emissions impact of biodiesel fuels in heavy-duty engines. It is the sole source of information on the NOx impact of B5 blends cited in the ISOR. When the engine dynamometer test data are examined for

[18] Durbin 2011, p. xx.

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the three engines for which emissions test data have been published, we find clear evidence that biodiesel increases NOx emissions in proportion to the blending percent. Where B5 fuels were tested for these engines, NOx emissions are found to increase above ULSD for both soy- and animal-based blends in all three engines and by statistically significant amounts in one engine.

Specifically, a re-analysis of the NOx emissions test data demonstrates the following:

1. For the 2006 Cummins engine, biodiesel fuels are found to significantly increase NOx emissions for both soy- and animal-based blends by amounts that are proportional to the blending percent. This result indicates that biodiesels will increase NOx emissions at blending levels below B10. When B5 fuels were tested, NOx emissions were observed to increase but by amounts that fail to reach statistical significance according to the pair-wise test.[19] Graphical analysis demonstrates that NOx emissions measured for B5 fuels are consistent with the Linear Model, but not the Staff Threshold Model.

2. For the 2007 MBD4000 engine, biodiesel fuels are found to significantly increase NOx emissions for both soy- and animal-based blends by amounts that are proportional to the blending percent. This result indicates that biodiesels will increase NOx emissions at blending levels below B10. When B5 fuels were tested, NOx emissions were observed to increase and by amounts that are found to be statistically significant using the pair-wise t-test.[13] This result alone is sufficient to disprove the Staff Threshold Model. Graphical analysis demonstrates that NOx emissions measured for B5 fuels are consistent with the Linear Model, but not the Staff Threshold Model.

3. For the 1998 Kubota TRU (off-road) engine, soy-based biodiesel fuels are found to significantly increase NOx missions. Animal-based biodiesel was not tested. When a soy-based B5 fuel was tested, NOx emissions were observed to increase but by amounts that fail to reach statistical significance according to the pair-wise test.[13] Graphical analysis demonstrates that NOx emissions measured for B5 fuels are consistent with the Linear Model, but not the Staff Threshold Model.

The measured emissions test data for the other off-road engine (2009 John Deere) are not contained in the Durbin 2011 report and CARB has not made them publicly available. Thus, a re-analysis was not possible. Based on the tables and figures in Durbin 2011, soy-based biodiesel fuels were shown to significantly increase NOx emissions at B20 levels and higher, but B5 was not tested. Testing of animal-based blends shows no change in NOx emissions at B5 and B20 levels, but B100 is shown to significantly increase NOx emissions. Durbin 2011 discusses this result only briefly, and it is unclear what conclusions can be drawn from it.

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[19] As discussed in Section 3.3, the pair-wise t-test is not the preferred method for demonstrating statistical significance.

Reproduction of Pages 167 - 204 Consisting of Comments ADF B3-146 through ADF B3-92

3_B_ADF_GE Responses (Page 322 – 358)

228. Comment**: NOx Emissions Impact of Soy- and Animal-based Biodiesel Fuels: A Re- Analysis December 10, 2013**

Agency Response:
This is the second time this document was submitted by Growth Energy. It is a reproduction of comments **ADF B3-46** through **ADF B3-92**. The responses to these comments are in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

APPENDIX A

RESUME OF ROBERT W. CRAWFORD

Education

1978 Doctoral Candidate, ScM. Physics, Brown University, Providence, Rhode Island
1976 B.A. Physics, Pomona College, Claremont, California

Professional Experience

1998-Present Independent Consultant

Individual consulting practice emphasizing the statistical analysis of environment and energy data with an emphasis on how data and statistics are properly used to make scientific inferences. Mr. Crawford provides support on statistical, data analysis, and modeling problems related to ambient air quality data and emissions from mobile and stationary sources.

Ambient Air Quality and Mobile Source Emissions – Mr. Crawford has worked with Sierra Research on elevated ambient CO and PM concentrations in Fairbanks AK and Phoenix AZ, including the effect of meteorological conditions on ambient concentrations, the relationship of concentrations to source inventories, and the use of non-parametric techniques to infer source location from wind speed and direction data. Ongoing work is employing Principal Components Analysis to elucidate the relationship between meteorology and $PM_{2.5}$ concentrations in Fairbanks. In the past year, this work led to creation of the AQ Alert System, a tool used by air quality staff to track $PM_{2.5}$ monitor concentrations during the day and to prepare AQ alerts over the next 3 days based on the meteorological forecast.

In past work for Sierra, he has also conducted studies of fuel effects on motor vehicle emissions for Sierra. For CRC, he determined the relationship between gasoline volatility and oxygen content on tailpipe emissions of late model vehicles at FTP and cold-ambient temperatures. For SEMPRA, he determined the relationship between CNG formulation and tailpipe emissions of criteria pollutants and a range of air toxics. Other work has included the design of vehicle surveillance surveys and determination of sample sizes, development of screening techniques similar to discriminant functions to improve the efficiency of vehicle recruitment, the analysis of vehicle failure rates measured in inspection & maintenance programs, and the statistical evaluation of data collected on freeway speeds using automated sensors.

Stationary Source Emissions – Over the past 5 years, Mr. Crawford has worked with AEMS, LLC on EPA's MACT and CISWI rulemakings for Portland Cement plants, in which significant issues related to data quality, data reliability, and emissions variability are evident. Key issues include the need to properly account for uncertainty and emissions variability in setting emission standards. He also supported AEMS in the

current EPA rulemaking on reporting of greenhouse gas emissions from semiconductor facilities, where the proper characterization of emission control device performance was a key issue. He is currently supporting AEMS in a regulatory process to re-determine emission standards for an industrial facility where the new standard will be enforced by continuous emissions monitoring (CEMS). At issue is how to set the standard in such a way that there will be no more than a small, defined risk that 30-day emission averages will exceed the limitations while emissions remain well-controlled .

Advanced Combustion Research – In recent work for Oak Ridge National Laboratory, Mr. Crawford conducted a series of statistical studies on the fuel consumption and emissions performance of Homogenous Charge Compression Ignition (HCCI) engines. One of these studies was for CRC, in which fuel chemistry impacts were examined in gasoline HCCI. In HCCI, the fuel is atomized and fully-mixed with the intake air charge outside the cylinder, inducted during the intake stroke, and then compressed to the point of spontaneous combustion. The timing of combustion is controlled by heating of the intake air. If R&D work can demonstrate a sufficient understanding of how fuel properties influence engine performance, the HCCI combustion strategy potentially offers the fuel economy benefit of a diesel engine with inherently lower emissions.

1979-1997 Energy and Environmental Analysis, Inc., Arlington, VA. Director & Partner (from 1989).

Primary work areas: Studies of U.S. energy industries for private and institutional clients emphasizing statistical analysis, business planning and computer modeling/forecasting. Responsible for the EEA practice area that provided strategic planning and forecasting services to major energy companies. Primary topical areas included: U.S. energy market analysis and strategic planning; gas utility operations; and natural gas supply planning.

U.S. Energy Market Analysis

During 1995-1997, Mr. Crawford directed EEA's program to provide comprehensive energy supply and demand forecasting for the Gas Research Institute (GRI) in its annual Baseline Projection of U.S. Energy Supply and Demand. Services included: development of U.S. energy supply, demand, and price forecasts; sector-specific analyses covering energy end-use (residential, commercial, industrial, transportation), electricity supply, and natural gas supply and transportation; and the preparation of a range of publications on the forecasts and energy sector trends.

From 1989 through 1997, he directed the use of EEA's Energy Overview Model in strategic planning and long-term market analysis for a client base of major energy producers, pipelines, and distributors in both the United States and Canada. The Energy Overview Model was used under his direction as the primary analytical basis for the 1992 National Petroleum Council study The Potential for Natural Gas in the United States. Mr. Crawford also provided analysis for clients on a wide range of other energy market issues, including negotiations related to an LNG import project intended to serve U.S. East Coast markets. This work assessed the utilization and economic value of seasonal

gas deliverability in order to develop LNG pricing formulas and evaluate the project's viability.

Other topical areas of work during his period of employment with EEA include:

Gas Load Analysis and Utility Operations – Principal investigator in a multi-year research program for the Gas Research Institute (GRI) that examined seasonal gas loads, utility operations, and the implications for transmission and storage system reliability and capacity planning.

Gas Transmission and Storage – Principal investigator for a study of industry plans for expansion of underground gas storage capacity in the post-Order 636 environment, including additions of depleted-reservoir and salt-formation storage, an engineering analysis of capital and operating costs for the projects, and unbundled rates for new storage services.

Natural Gas Supply Planning – Mr. Crawford was EEA's senior manager and lead analyst on gas supply planning issues for both pipeline and distribution companies, which included technical and analytic support in development and justification of gas supply strategies; and identification of optimal seasonal supply portfolios for Integrated Resource Planning proceedings.

Transportation Systems Research

Mr. Crawford also had extensive experience in motor vehicle fuel economy and emissions while at EEA. He participated for five years in a DOE research program on fuel economy, with emphasis on the evaluation of differences between laboratory and on-road fuel economy. His work included analysis of vehicle use databases to understand how driving patterns and ambient (environmental) conditions influence actual on-road fuel economy. He also developed a software system to link vehicle certification data systems to vehicle inspection and testing programs and participated in a range of studies on vehicle technology, fuel economy, and emissions for DOE, EPA, and other governmental agencies.

SELECTED PUBLICATIONS (emissions and motor vehicle-related topics)

Statistical Assessment of $PM_{2.5}$ and Meteorology in Fairbanks, Alaska: 2013 Update. Crawford and Dulla. Prepared for the Alaska Department of Environmental Conservation. (forthcoming).

Statistical Assessment of $PM_{2.5}$ and Meteorology in Fairbanks, Alaska. Crawford and Dulla. Prepared for the Alaska Department of Environmental Conservation. March 2012.

Principal Component Analysis: Inventory Insights and Speciated $PM_{2.5}$ Estimates. Crawford. Presentation at Air Quality Symposium 2011, Fairbanks and North Star Borough, Fairbanks, AK. January 2011.

Influence of Meteorology on $PM_{2.5}$ Concentrations in Fairbanks Alaska: Winter 2008-2009. Crawford. Presentation at Air Quality Symposium 2009, Fairbanks and North Star Borough, Fairbanks, AK. July 2009.

Analysis of the Effect of Fuel Chemistry and Properties on HCCI Engine Operation: A Re-Analysis Using a PCA Representation of Fuels. Bunting and Crawford. 2009. Draft Report (CRC Project AFVL13C)

The Chemistry, Properties, and HCCI Combustion Behavior of Refinery Streams Derived from Canadian Oil Sands Crude. Bunting, Fairbridge, Mitchell, Crawford, et al. 2008. (SAE 08FFL 28)

The Relationships of Diesel Fuel Properties, Chemistry, and HCCI Engine Performance as Determined by Principal Components Analysis. Bunting and Crawford. 2007. (SAE 07FFL 64).

Review and Critique of Data and Methodologies used in EPA Proposed Utility Mercury MACT Rulemaking, prepared by AEMS and RWCrawford Energy Systems for the National Mining Association. April 2004.

PCR+ in Diesel Fuels and Emissions Research. McAdams, Crawford, Hadder. March 2002. ORNL/TM-2002/16.

A Vector Approach to Regression Analysis and its Application to Heavy-duty Diesel Emissions. McAdams, Crawford, Hadder. November 2000. ORNL/TM-2000/5.

A Vector Approach to Regression Analysis and its Application to Heavy-duty Diesel Emissions. McAdams, Crawford, Hadder. June 2000. (SAE 2000-01-1961).

Reconciliation of Differences in the Results of Published Shortfall Analyses of 1981 Model Year Cars. Prepared by Energy and Environmental Analysis, Inc. for the U.S. Department of Energy under Contract DE-AC01-79PE-70045. October 1985

Short Test Results on 1980-1981 Passenger Cars from the Arizona Inspection and Maintenance Program. Darlington, Crawford, Sashihara. August 1984.

Seasonal and Regional MPG as Influenced by Environmental Conditions and Travel Patterns. Prepared by Energy and Environmental Analysis, Inc. for the U.S. Department of Energy under Contract DE-AC01-79PE-70045. March 1983.

Comparison of EPA and On-Road Fuel Economy -- Analysis Approaches, Trends, and Impacts. McNutt, Dulla, Crawford, McAdams, Morse. June 1982. (SAE 820788)

Regionalization of In-Use Fuel Economy Effects. Prepared by Energy and Environmental Analysis, Inc. for the U.S. Department of Energy under Contract DE-AC01-79PE-70032. April 1982.

1985 Light-Duty Truck Fuel Economy. Duleep, Kuhn, Crawford. October 1980. (SAE 801387)

PROFESSIONAL AFFILIATIONS

Member, Society of Automotive Engineers.

HONORS AND AWARDS

2006 Barry D. McNutt Award for Excellence in Automotive Policy Analysis. Society of Automotive Engineers.

US Patent 7018524 (McAdams, Crawford, Hadder, McNutt). Reformulated diesel fuels for automotive diesel engines which meet the requirements of ASTM 975-02 and provide significantly reduced emissions of nitrogen oxides (NO_x) and particulate matter (PM) relative to commercially available diesel fuels.

US Patent 7096123 (McAdams, Crawford, Hadder, McNutt). A method for mathematically identifying at least one diesel fuel suitable for combustion in an automotive diesel engine with significantly reduced emissions and producible from known petroleum blend stocks using known refining processes, including the use of cetane additives (ignition improvers) and oxygenated compounds.

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3_B_ADF_GE Responses (Page 359 – 364)

229. Comment**: Robert Crawford's Resume**

Agency Response:
This is submittal two of three of Robert Crawford's resume to the ADF docket. It does not constitute an objection or suggestion on the proposal.

ATTACHMENT D

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America's Ethanol Supporters

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August 15, 2014

Via Electronic Mail

Mr. Alexander Mitchel
Transportation Fuels Branch
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Alternative Diesel Fuel Rulemaking

Dear Mr. Mitchell:

Please find attached the comments of Growth Energy in response to the staff's request for public input on alternatives to the 2013 regulatory proposal for the Alternative Diesel Fuel regulation. Growth Energy hopes to make a further submission regarding regulatory alternatives following the public consultation meeting to discuss biodiesel emissions testing sponsored by the Board.

Please place this letter and its attachments in the public docket that I understand the staff is establishing for materials it receives in connection with this rulemaking effort.

ADF B3-128

Sincerely,

David Bearden
General Counsel and Secretary

cc: Dr. Irena Asmundson (via Electronic Mail)
Mr. Michael S. Waugh (via Electronic Mail)

STATE OF CALIFORNIA

AIR RESOURCES BOARD

RESPONSE TO REQUEST FOR PUBLIC INPUT ON REGULATION OF ALTERNATIVE DIESEL FUEL

GROWTH ENERGY

AUGUST 15, 2014

Growth Energy's Response to Request for Public Input
On Regulation of Alternative Diesel Fuel

Growth Energy respectfully submits this response to the request by the staff of the California Air Resources Board ("CARB") for public input on alternatives to the staff's currently proposed method for regulating the use of alternative diesel fuel ("ADF") as part of compliance with the low-carbon fuel standard ("LCFS") regulation. The CARB staff presented its request for public comment in a notice dated July 29, 2014, and has established today as the deadline for that input. In these brief comments, Growth Energy assumes CARB's familiarity with and incorporates by reference its June 23, 2014 submission in response to a similar staff request concerning the LCFS regulation itself, as well as Growth Energy's submissions in an earlier phase of the ADF rulemaking in 2013.

I. Introduction and Background

The stated purpose of the July 29 notice is to seek input on regulatory alternatives pursuant to the 2011 amendments to the Government Code contained in SB 617. The proposed ADF regulation is intended to provide a legal pathway for new emerging diesel fuel substitutes to enter the commercial market in California, while managing and minimizing environmental and public health impacts, and to preserve the emission benefits derived from the CARB motor vehicle diesel regulations.[1] In light of that goal, the current ADF rulemaking as most recently described by CARB staff would establish:

ADF B3-129

- A general process governing the commercialization of new ADF formulations in California, and
- Specific requirements for biodiesel and biodiesel blends that are consistent with the general ADF process and that would mitigate increases in emissions of oxides

[1] *See* "Initial Statement of Reasons, Proposed Regulation on the Commercialization of New Alternative Diesel Fuel," October 23, 2013 available at http://www.arb.ca.gov/regact/2013/adf2013/adf2013isor.pdf.

> of nitrogen (NOx) from diesel engines and vehicles that have been identified to occur relative to conventional California diesel fuel from the use of biodiesel and biodiesel blends.[2]

There are no specific compositional requirements proposed for ADFs other than "biodiesel," inasmuch as none have yet sought to be commercialized in California.

CARB has a duty to mitigate any potential significant environmental impacts that could result from commercialization of biodiesel. Mitigation strategies will drive the costs and affect the benefits of the ADF regulation, and so the first step in the SB 617 process for the ADF regulation should be to develop a range of potential mitigation strategies. CARB has sponsored, but has not yet fully digested, a body of tests using biodiesel fuels. The CARB staff, for its part, has recently asserted that those tests have informed several major findings about mitigation strategies; nevertheless, the staff also acknowledges that some of its major findings are preliminary and subject to change because the data upon which they are based has only recently made available to the public. Nor has the CARB staff fully developed and explained its findings. Once the staff does so, it should then seek better-informed public input under SB 617.

ADF B3-129 cont.

Based on its current analysis, the CARB staff has indicated that it expects that the yet unpublished proposed ADF regulation will require NOx mitigation for biodiesel blends containing more than five percent of an animal-based biodiesel or more than one percent of soy-based or other types of biodiesel blends. Staff also indicates that it expects to propose an exemption for all biodiesel blends when used in vehicle fleets containing more than 95% "new technology diesel engines (NTDEs)"[3] from NOx mitigation requirements and a sunset clause

ADF B3-130

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[2] *See* "Preliminary Rulemaking Proposal for Biodiesel Use as an Alternative Diesel Fuel," July 29, 2014 available at http://www.arb.ca.gov/fuels/diesel/altdiesel/20140729ADF_SRIA_Proposal.pdf.

[3] In the October 23, 2013 Initial Statement Reasons, CARB staff defined NTDEs as meaning:

eliminating all NOx mitigation requirements "once NTDEs represent 95 percent of the heavy duty diesel engines in California."

The CARB staff's approach appears to rest on two beliefs: (i) no NOx increases occur in blends containing five percent or less of animal-based biodiesel or one percent or less of soy-based or other biodiesel; and (ii) there are no NOx increases from biodiesel use in NTDEs.

Turning first to the need to mitigate NOx emissions for animal-based biodiesel blends below five percent and below one percent for soy-based and other biodiesel blends, the flaws here are due to the fact that the CARB staff continues to cling to the concept of there being a "threshold" biodiesel blend level below which there are no increases in NOx emissions, rather than accepting that there is a linear relationship between NOx emissions and increases in biodiesel content. That the staff's "threshold" model is flawed with respect to both soy- and animal-based biodiesel blends and should be replaced by the linear model was made clear in a technical report prepared by Robert Crawford[4] that was submitted to CARB as part of Growth Energy's formal comments on the abandoned 2013 ADF rulemaking.

ADF B3-130 cont.

With respect to the impact of biodiesel on NOx emissions from NTDEs, CARB staff's major finding in this area — that biodiesel does not increase NOx emissions from NTDEs — continues to rely, as it did in the October 2013 rulemaking, on only one reference, a paper by

ADF B3-131

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a diesel engine that meets at least one of the following criteria:

(1) 2010 ARB emission standards for on-road heavy duty diesel engines under 13 CCR 1956.8,
(2) Tier 4 emission standards for non-road compression ignition engines under 13 CCR 2421, 2423, 2424, 2425, 2425.1, 2426, and 2427, or
(3) equipped with or employs a Diesel Emissions Control Strategy (DECS), verified by ARB pursuant to 13 CCR 2700 et seq., which uses selective catalytic reduction to control NOx.

ADF B3-130 cont.

[4] Crawford, R., "NOx Emission Impact of Soy- and Animal-based Biodiesel Fuels: A Reanalysis," December 10, 2013.

Lammert *et al.*[5] The flaws in the basis for this major finding were explained in Growth Energy's submission in the 2013 ADF rulemaking.[6] A 2014 peer-reviewed publication authored by researchers from the University of California at Riverside[7] (Gysel, *et al.*) who report results from a study funded by the South Coast Air Quality Management District confirms that CARB staff's major finding in this area is flawed. With respect to biodiesel impacts on NOx emissions from NTDEs, Gysel *et al.* report large percentage increases in NOx emissions with biodiesel use in NTDEs and state:

> Lammert *et al.* showed that the effect of SCR aftertreatment negates the effect of fuels on NOx emissions when they tested a 2011 Cummins ISL engine on B20 and B100. This is in strong contrast to the current study vehicle shows that there is rather strong fuel effect with the B50 blends compared to CARB ULSD from the Cummins ISX-15 engine with SCR.

In addition, Gysel *et al.*, provides a discussion referencing at least four other peer-reviewed technical papers[8] which further confirm this flaw in the staff's finding, showing increases in

ADF B3-131 cont.

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[5] Lammert, M., McCormick, R., Sindler, P. and Williams, A., "Effect of B20 and Low Aromatic Diesel on Transit Bus NOx Emissions Over Driving Cycles with a Range of Kinetic Intensity," *SAE Int. J. Fuels Lubr.* 5(3):2012, doi:10.4271/2012-01-1984.

[6] As an expert stated in Growth Energy's submission:

> ... [T]he CARB staff's unequivocal statements regarding the impact of biodiesel on NOx emissions from all vehicles with NTDEs is simply not reasonable based on data from (1) a single study that (2) tested only two urban buses equipped with the same engine and (3) used instrumentation that was, at best, barely able to measure NOx emissions from the test vehicles in general, and clearly was not sensitive enough to reliably detect changes in NOx emissions due to use of different fuels. Nothing else in the rulemaking file supports the CARB staff's claim that there will not be increased NOx emissions from the use of biodiesel in NTDEs.

Declaration of James M. Lyons, ¶ 23 (Dec. 12, 2013).

[7] Gysel, N., Karavalakis, G., Durbin, T., Schmitz, D., and Cho, A., "Emission and Redox Activity of Biodiesel Blends Obtained from Different Feedstocks from a Heavy-Duty Vehicle Equipped with DFS/SCR Aftertreatment and a Heavy-Duty Vehicle without Control Aftertreatment," SAE Technical Paper 2014-01-1400, April 1, 2014.

[8] Walkowicz, K., Na, K., Robertson, W., Sahay, K., Bogdanoff, M., Weaver C., and Carlson, R., "On-road and In-Laboratory Testing to Demonstrate Effects of ULSD, B20 and B99 on a Retrofit Urea-SCR Aftertreatment System," SAE Technical Paper 2009-01-2733, November 2, 2009; McWilliam, L. and Zimmermann, A., "Emissions and Performance Implications of Biodiesel Use in an SCR-equipped Caterpillar C6.6," SAE Technical Paper 2010-01-2157, October 25, 2010; Mizushima, N., Murata, Y., Suzuki, H., Ishii, H., Goto, Y.,

NOx emissions from biodesel use with NTDEs. It should also be noted that the observed NOx increases from biodiesel use in NTDEs are consistent with the widely accepted linear model form which Crawford's report demonstrates is technical superior to CARB's flawed threshold model.

ADF B3-131 cont.

II. Necessary Changes in the CARB Staff's Approach

In light of the currently available data and the relevant literature, the CARB staff's current approach is insufficient to mitigate the impacts of biodiesel usage. On that basis, Growth Energy asks the staff to consider a regulatory alternative having the following three key elements:

ADF B3-132

1. Require that the mitigation strategies for increased NOx emissions be applied to all biodiesel and blends of biodiesel and diesel fuel where biodiesel was intentionally blended.[9]

ADF B3-133

2. Eliminate exemptions from NOx mitigation requirements for biodiesel used in vehicle fleets comprised of at least 95% NTDEs.

ADF B3-134

3. Eliminate the sunset provision for NOx mitigation requirements.

ADF B3-135

It is critical for the staff to evaluate the need for those three changes in light of other measures that CARB has adopted or is considering adopting to reduce NOx emissions, including the Advanced Clean Cars program and CARB's Sustainable Freight Transport Initiative which involve requirements for "zero-emission" heavy-duty vehicles.

ADF B3-136

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and Kawano, D., "Effect of Biodiesel on NOx Reduction Performance of Urea-SCR System," SAE Technical Paper 2010-01-2278, October 25, 2010.

[9] The reference to intentional blending has been included to ensure that mitigation is not required for inadvertent blends of biodiesel and diesel that could result from mixing of diesel with biodiesel remaining in storage tanks or in fuel transfer lines.

Growth Energy appreciates the opportunity to provide this input on alternatives to the current approach to developing an ADF regulation, and as noted above, plans to provide additional input once the CARB staff has reviewed the available data in one or more workshops.

Respectfully submitted,

GROWTH ENERGY

3_B_ADF_GE Responses (Page 365 – 376)

230. Comment: **ADF B3-130 through ADF B3-136**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

231. Comment: **ADF B3-128**
The comment states that their attached documentation is in response to the current ADF proposal and requests that the attached file be placed in the docket.

Agency Response:
The comment does not constitute an objection or recommendation regarding the 2015 ADF regulation. The attached documentation was placed in the docket.

232. Comment: **ADF B3-129**
The comment states that when ARB staff finalizes the testing and analysis, the agency should seek public input via the SRIA process.

Agency Response:
The comment is not directed to the ADF proposal considered for adoption by the Air Resources Board in 2015, but instead to a solicitation by ARB, for alternatives made July 29, 2014. For more information on compliance with SB 617, please see response **ADF 17-1.** Regarding final testing and analysis, the ADF staff report contains the final conclusions and response **ADF 17-3** provides detail that some commenters requested, the response is located in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

STATE OF CALIFORNIA

AIR RESOURCES BOARD

RESPONSE TO REQUEST FOR PUBLIC INPUT ON ALTERNATIVES TO THE LOW- CARBON FUEL STANDARD REGULATION

GROWTH ENERGY

JUNE 23, 2014

Executive Summary

The staff of the California Air Resources Board ("CARB") has identified the Low-Carbon Fuel Standard ("LCFS") as a "major regulation" that requires enhanced review for compliance with SB 617 (Calderon and Pavley), a 2011 amendment to the California Administrative Procedure Act (the "APA"). The California Department of Finance ("the Department") has published regulations that implement SB 617. Those regulations require rulemaking agencies like CARB to seek early public input on possible alternatives to the rules being developed by the rulemaking agencies.

Growth Energy, an association of the Nation's leading ethanol producers and other companies that serve America's need for renewable fuels, is submitting to the CARB staff a proposed alternative to the LCFS regulation that would allow the State to eliminate the LCFS program without loss of environmental benefits. Growth Energy's proposal recognizes important changes in the regulatory baseline for the control of greenhouse gas ("GHG") emissions that have occurred since 2009. In particular, the federal renewable fuels standard ("RFS") program, combined with the California cap-and-trade program and a number of California-specific vehicle- and engine-based regulations, now assure that California will receive most if not all of the direct GHG emissions reductions that can be attributed to the LCFS regulation. To the extent that CARB believes that there is still an emissions shortfall from elimination of the LCFS or that it has authority to address lifecycle GHG emissions occurring outside of California under state and federal law (which are issues not addressed in this submittal), Growth Energy proposes that CARB address those remaining issues by modifying the California GHG cap-and-trade regulations, which are now in effect in California and which apply to transportation fuels providers beginning in 2015.

Growth Energy's description of its proposed alternative to the LCFS regulation is as detailed as possible, given currently available information. In this submittal, Growth Energy urges the CARB staff to provide the additional information needed to provide further analysis of alternatives to the LCFS regulation.

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Growth Energy's Response to Request for Public Input
On Alternatives to the Low-Carbon Fuel Standard Regulation

Growth Energy respectfully submits this response to the request by the staff of the California Air Resources Board ("CARB") for public input on alternatives to the low-carbon fuel standard ("LCFS") regulation. The CARB staff presented its request for public comment in a notice dated May 23, 2014, and has established today as the deadline for that input.

The CARB staff is seeking public input in connection with its proposal that CARB revise and readopt the LCFS regulation at a public hearing later this year. The purpose of the LCFS regulation, which the Board first adopted in 2009, is to achieve reductions in greenhouse gas ("GHG") emissions from the California transportation sector pursuant to the Global Warming Solutions Act of 2006, commonly called AB 32. Other regulations adopted since 2008 under AB 32 to achieve the same objectives as the LCFS regulation include the "cap and trade" regulation (17 C.C.R. §§ 95801-96022), the GHG emissions standards contained in the Advanced Clean Cars (or "ACC") program (13 C.C.R. §§ 1960.1-1962.2), and a set of regulations to control GHG emissions from heavy-duty vehicles and engines.[1]

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Overview

Growth Energy has organized its analysis of alternatives to the LCFS regulation in this submission into four parts.

Part I of this submission briefly outlines the statutory and regulatory framework for the CARB staff's request for input on alternatives to the LCFS regulation. As explained in Part I, regulations adopted by the California Department of Finance pursuant to a recent amendment to the APA require CARB to seek and permit effective early public input on rulemaking concerning

[1] These include California's Heavy-Duty GHG regulations now completing the rulemaking process, a second phase of regulations that are under development, and the so-called "Tractor-Trailer" GHG regulation adopted in 2008. *See* http://www.arb.ca.gov/regact/2013/hdghg2013; http://www.arb.ca.gov/cc/hdghg/hdghg.htm.

"major" regulations, including the LCFS. That amendment was contained in SB 617 (Calderon and Pavley). The LCFS rulemaking, and this stage of the LCFS rulemaking, are particularly important, because this rulemaking is one of the first CARB rulemakings governed by SB 617. *See* pp. 4-7 below.

Part II of Growth Energy's submittal addresses some of the important factors that affect a regulatory alternatives analysis undertaken under SB 617. Since 2009, there have been significant changes in the "baseline" conditions for GHG regulation relevant to the LCFS program. As explained in Part II, most of the GHG emissions reductions sought by CARB when it adopted the LCFS regulation in 2009 will be provided by a combination of the federal renewable fuels standard ("RFS") program, along with California's cap-and-trade regulation, ACC program, and regulations limiting GHG emissions from heavy-duty vehicles and engines. Given that most, if not all, of the GHG emissions reductions sought by CARB in 2009 through the LCFS regulation are now assured by those other programs, the LCFS regulation has been rendered largely superfluous from an environmental perspective, even though it imposes huge financial burdens on the regulated community and requires a large commitment of resources by CARB. As a threshold matter, CARB should therefore carefully and fully consider whether, based on regulatory and program developments related to GHG emission control since 2009, there is any continuing need for the LCFS regulation. *See* pp. 8-14 below.

Part III of this submittal explains that, to the extent that the CARB staff finds any continuing need for the LCFS regulation to control GHG emissions, that need could be met instead through a simple modification of the cap-and-trade regulation. Taking that step -- modifying the cap-and-trade regulation -- would fully eliminate any conceivable remaining need for the LCFS regulation, while doing nothing to alter CARB's overall regulatory strategy to

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address GHG emissions from the California transportation sector. The GHG emissions reductions benefits of the LCFS program would be fully realized from the suite of other GHG regulations adopted federally and in California since 2009, and by the modification of the cap-and-trade program. The direct regulatory costs of the LCFS program are borne primarily by the California motor vehicle fuels marketing industry, which can to some extent pass those costs to its retail customers. Insofar as the LCFS program imposes costs on California businesses and consumers, the alternative presented here (relying on the cap-and-trade program) would not materially alter the allocation of costs and would at the same time reduce regulatory costs by eliminating an entire regulatory program (the LCFS regulation). Judging from the strong concern about the LCFS regulation expressed by oil industry stakeholders, the regulatory relief and reform proposed here warrants full consideration and further development. *See* pp. 14-20 below.

Part IV of Growth Energy's submittal recommends specific next steps that CARB should consider, including full involvement by the Chief Counsel's Office to ensure compliance with the APA. As will be apparent throughout this submittal, Growth Energy's analysis of regulatory alternatives can be no more detailed than the publicly available information about (i) the new version of the LCFS regulation that the CARB staff is considering for proposal to the Board, and (ii) the information that the CARB staff has provided about the benefits that it is attributing to the LCFS program. Contrary to the position taken in communications to Growth Energy by CARB's Transportation Fuels Section on this subject, very little information on the new version of the LCFS regulation or its estimated benefits -- which are critical to an effective SB 617 process -- has been provided to the public to date. In order to achieve substantial compliance with the APA, the CARB staff needs to provide the public with a full picture of its proposed new

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LCFS regulation, and in particular describe any new features of the regulation intended to reduce compliance costs. The CARB staff also needs to completely identify for the public all benefits that it is attributing to the LCFS regulation that would bear on an SB 617 alternatives analysis. Then, after the public has had sufficient time to analyze the relevant information from CARB, the public should be permitted to provide updated regulatory alternative analyses, which the CARB staff should fully consider and address in the Standardized Regulatory Impact Assessment required by 1 C.C.R. § 2002. That approach would ensure compliance with the APA, without conflicting or otherwise undermining any other mandates or obligations applicable to the LCFS regulation. *See* pp. 20-24 below.

I. The Statutory Framework for the Regulatory Alternatives Analysis under SB 617

The CARB staff is seeking submittals from the public on regulatory alternatives to the LCFS regulation because it has a legal obligation to do so. For many years, section 11346.3 of the APA has provided in part as follows:

> (a) State agencies proposing to adopt, amend, or repeal any administrative regulation shall assess the potential for adverse economic impact on California business enterprises and individuals, avoiding the imposition of unnecessary or unreasonable regulations or reporting, recordkeeping, or compliance requirements. ...
>
> (2) The state agency, prior to submitting a proposal to adopt, amend, or repeal a regulation to the office, shall consider the proposal's impact on business, with consideration of industries affected including the ability of California businesses to compete with businesses in other states. For purposes of evaluating the impact on the ability of California businesses to compete with businesses in other states, an agency shall consider, but not be limited to, information supplied by interested parties.

Cal. Gov't Code § 11346.3(a)(2). Based on evidence that rulemaking agencies did not adequately consider the burdens that regulations impose on the public, in SB 617 the Legislature added a requirement that rulemaking agencies prepare a detailed assessment of the costs and benefits of any proposed major regulation, for review by the California Department of Finance

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("the Department") ***before*** initiating the traditional informal rulemaking process. *See id.* § 11346.3(c). Those detailed assessments are called Standardized Regulatory Impact Assessments (or "SRIAs."). *See id.* § 11346.36. The Legislature also made it clear in SB 617 that the obligation to consider and use early public input on regulatory impacts could not be met by merely going through the formalities of seeking public input.[2]

The Department completed work on regulations to implement SB 617 in the fall of 2013. The Department's regulations require, among other steps, the following:

> The [rulemaking] agency shall also seek public input regarding alternatives from those who would be subject to or affected by the regulations ... prior to filing a notice of proposed action with OAL unless the agency is required to implement federal law and regulations which the agency has little or no discretion to vary. An agency shall document and include in the SRIA the methods by which it sought public input.

1 C.C.R. § 2001(d). As the rulemaking file for the Department's regulations implementing SB 617 shows, many state regulatory agencies, CARB not excepted, recognized that SB 617 (as implemented by the Department) would mean the end of "business as usual" in the California rulemaking process.[3]

In responding to objections from rulemaking agencies concerning the obligations created by its SB 617 regulations, the Department explained that "[i]nvolving the Department and affected parties early in the [rulemaking] process could result in the discovery of additional and

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[2] Thus, SB 617 deleted text from section 11346.3(a)(2) of the APA that, up to 2011, had provided that the APA's public-input requirements were not "inten[ded]" to "impose additional criteria on agencies" engaged in rulemaking. *See* Stats. 2011, c.496 (SB 617), subd. (a); Cal. Office of Admin. Law, *California Rulemaking Law under the Administrative Procedure Act* (2012) 57 (legislative history of section 11346.3).

[3] Several rulemaking agencies filed sharp objections to the Department's proposed regulations to implement SB 617 on the ground that the regulations would require major changes in the timing used by the agencies to develop regulations and to obtain public input. *See, e.g.,* Dep't of Finance, *Regulations to Implement SB 617 Re Major Regulations, Responses to 45-day Comment Period (Chart A)* (hereinafter "Chart A"), available at http://www.dof.ca.gov/research/economic_research_unit/SB617_regulation/documents/Response%20to%20Comments%20Chart A.pdf. The Department dealt fully with all those objections and made no material changes in its proposed regulations to implement SB 617.

perhaps more cost-effective alternatives to [a] proposed major regulation, consistent with the intent of SB 617."[4] Similarly, when rulemaking agencies (including CARB) objected to the burdens of preparing the early regulatory analyses of costs and benefits needed for an effective SB 617 process, the Department correctly concluded that the amended APA "clearly contemplates that an agency will have considered [regulatory] alternatives prior to filing a notice of a proposed action" with the Office of Administrative Law and publication of the regulatory notice for further public comment.[5] The Department also made it clear that under the SB 617 process, the "no action" alternative to regulation -- which is an outcome seldom if ever seen in a major California rulemaking -- had to receive full and fair consideration at the beginning of the rulemaking process.[6]

In requiring significant change in the California rulemaking process, the statute and the implementing regulations are salutary. The LCFS regulation in 2009 was typical of major rulemakings affecting the motor vehicle fuels industries in California. Beginning in 2008, CARB had convened a series of public consultation meetings prior to its formal proposal for rulemaking in March 2009. Not until publication of the Initial Statement of Reasons for the LCFS regulation, however, was the public given any opportunity to review the economic analysis of costs and benefits for the proposed regulation; the written comments on economic issues were due a scant 45 days later (in April 2009), and at the Board's April 2009 public hearing, most private-sector speakers were limited to five minutes to make a presentation to

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4 *See* Chart A at 24.

5 *Id.* at 27.

6 *Id.* at 47-48.

CARB. The public cannot have a significant role in serious economic analysis of a major regulation within such a constrained process.

Unsurprisingly, major economic assumptions and issues were not fully addressed within the time frame for written comments in March to April 2009, nor at the Board hearing. Among the assumptions and factors that could not as a practical matter be "pressure-tested" in the public comment process was the CARB staff's belief that advanced ethanol production methods would eventually drive down gasoline costs at the retail level and make the LCFS program cost-neutral for California consumers or even generate savings of up to $11 billion.[7] That assumption was unsound in 2009, and has since been disproven by experience.[8] Likewise, in the 2009 rulemaking, the CARB staff gave little attention to the ability of the federal RFS program to accomplish the same goals and purposes of the LCFS regulation, and offered largely opaque comparisons between the GHG reductions that the two programs could achieve. Now in its fifth year of implementation, the LCFS regulation has made little or no impact on the supply of lower-GHG fuels in California.[9] SB 617 and the Department's implementing regulations require the Board to improve the quality and depth of the economic analysis for major regulations like the LCFS program.

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7 Air Resources Board, *Proposed Regulation to Implement the Low Carbon Fuel Standard -- Staff Report: Initial Statement of Reasons* (hereinafter "ISOR") at ES-26.

8 As the ISOR itself noted, "Economic factors, such as tight supplies of lower-carbon-intensity fuels ... could result in overall net costs, not savings, for the LCFS." The fact that the cost savings forecast in 2009 proved ephemeral is implicit in the CARB staff's decision, less than two years after the regulation went into effect, to develop "cost reduction" features for the LCFS regulation, which would assist "regulated parties ... unable to meet their compliance obligations ... due to limited supplies of low carbon fuels or LCFS credits in the market." Air Resources Board, *Low Carbon Fuel Standard 2011 Program Review Report* (Dec. 8, 2011) (hereinafter "2011 Program Review") 16.

9 There have been substantial increases in the efficiency of Midwest corn ethanol production facilities since CARB first embarked on the LCFS rulemaking, and those increases have reduced the lifecycle GHG emissions of those facilities under some analyses; but those reductions in GHG emissions have been caused by market forces (the need to reduce energy consumption in order to remain competitive), not by virtue of the LCFS regulation. *See* note 25 below.

II. Factors Affecting the Regulatory Alternatives Analysis

According to the CARB staff, the goal of the LCFS regulation in 2009 was, and still remains, to "reduce the carbon intensity of transportation fuels used in California by at least 10 percent by 2020 from a 2010 baseline," and also to "support the development of a diversity of cleaner fuels with other attendant co-benefits."[10] Growth Energy sought clarification of the staff's description of the goals of the regulation for purposes of its input in the SB 617 process.[11] Lacking greater specificity or clarification, Growth Energy can only turn to the 2009 rulemaking, in which CARB quantified the "10 percent" target as being a reduction of 16 million metric tons of carbon dioxide equivalent ("MMTCO2eq") GHG emissions associated with combustion of transportation fuels in California, along with a 7 MMTCO2eq reduction in "upstream" emissions, yielding a total 23 MMTCO2eq reduction in worldwide annual GHG emissions in 2020.[12] As explained below, achieving the direct GHG emissions reduction attributed to the LCFS regulation in 2009 -- the 16 MMTCO2eq -- no longer requires the existence of the LCFS regulation.

A. Changes in the Regulatory Baseline Since 2009

The most significant development in the regulatory baseline since 2009 has been the adoption and full implementation of the federal renewable fuels standard program under the Energy Independence and Security Act of 2007, pursuant to a Final Rule adopted by the U.S.

[10] The staff identified that goal on June 5, 2014, well after the period for preparation of SB 617 public input had begun, in response to a specific request from Growth Energy. *See* Letter from D. Bearden to K. King, May 30, 2014 (included here as Attachment 1) *and* Letter from M. Waugh to D. Bearden, June 5, 2014 (included here as Attachment 2).

[11] *See* Letter from D. Bearden to M. Waugh, June 11, 2014 (included here as Attachment 3). To date, no response to Mr. Bearden's letter of June 11, 2014, has been received.

[12] *See* ISOR at VII-1. According to the 2009 ISOR, "These reductions account for a 10 percent reduction of the GHG emissions from the use of transportation fuel." *Id.* That 10 percent target, which the CARB staff also sometimes cites, originates in Executive Order S-01-07 of January 18, 2007. *See* Executive Order S-01-07, § 1, available at http://www.arb.ca.gov/fuels/lcfs/eos0107.pdf.

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Environmental Protection Agency in 2010.[13] The federal RFS program assures an adequate supply of low-cost renewable fuel for California, *i.e.*, ethanol produced from corn starch at biorefineries located mainly in the Midwest.[14] Because ethanol produced by any method from any renewable feedstock has the same physical and chemical properties when used in motor fuel, gasoline blended with 10 percent ethanol will achieve the same reduction in exhaust or "tailpipe" GHG emissions regardless of the production process or renewable feedstock used to create the ethanol. Consequently, the portion of the 16 MMTCO2eq reduction in GHG emissions from the California transportation fleet operated on gasoline can and will be obtained by virtue of the federal RFS program.[15] Oil companies will continue to buy and blend ethanol into gasoline sold in California under the federal program even if there were no LCFS program, in order to comply with the federal RFS program. The portion of the California fleet operated on diesel fuel can also achieve its part of the 16 MMTCO2eq reduction in GHG emissions by virtue of the federal RFS

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[13] *See* U.S. EPA, *Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Final Rule*, 75 Fed. Reg. 14,669 (Mar. 26, 2010) .

[14] The RFS program, which in its early stages was effectively non-binding on ethanol usage, has begun to cause substantial increases in biofuel production. Total production of biofuels has increased steadily over the last year and a half, reaching approximately 16 billion gallons in the 12 months through April 2014. *See* http://www.epa.gov/otaq/fuels/rfsdata/.

[15] The term "fleet," as used here, includes off-road vehicles and engines in other equipment.

When the CARB staff considered the matter in 2009, it made a number of assumptions about the efficacy of the federal RFS program that need to be reconsidered. The most significant assumption, which was empirically unsupported, was that the federal program (which at the time was still under development) would provide only 30 to 40 percent of the GHG reductions that the staff predicted for the LCFS program. That assumption appears to have been based on a belief that without the LCFS regulation, only 11.3 percent of the advanced or cellulosic biofuels required nationwide by the RFS program would be consumed in California, while a substantially higher amount of those fuels would be drawn from the nationwide fuel pool to California as the result of the LCFS regulation. The advanced biofuels required by the RFS regulation that would be drawn to California by the LCFS program would have been used elsewhere in the absence of the LCFS program, leading to the same reductions in GHG emissions. To the extent that the cellulosic ethanol industry has experienced limits on achieving full commercial launch, those are national and even global economic and technical factors that the existence of the LCFS regulation has not to date, and will not in the future, be able to change or influence.

program, because the federal program results in blending biodiesel and renewable diesel into diesel fuel produced from petroleum.[16]

As for the portion of the California fleet powered in whole or in part with electricity or hydrogen, there is similarly no continuing need for the LCFS program, owing to other changes in the regulatory baseline since 2009. The Advanced Clean Cars program now assures that electricity and hydrogen will be full participants in the California transportation fuel pool. In 2009, CARB's baseline for the alternatives analysis of the LCFS regulation included the then-current version of the Board's regulations to control GHG emissions from new motor vehicles that had been adopted in 2004, and that set GHG emission standards for 2009 to 2016 model-year new vehicles, sometimes called the "Pavley standards." In addition, the baseline also included the then-current provisions of the agency's Zero Emission Vehicle ("ZEV") standards which require manufacturers offer electric and/or hydrogen fuel cell vehicles for sale in California. CARB has now adopted new-vehicle GHG standards applicable to 2017 to 2025 model-year new vehicles and has made significant revisions to the ZEV standards as part of the ACC rulemaking in 2012.[17]

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[16] One reason why California is assured of receiving an adequate supply of ethanol is that ethanol for use in gasoline commands a higher price -- the so-called "California premium" -- in California than in other parts of the United States, as can be readily seen from data available under contract or license from the Oil Price Information Service ("OPIS"). While there are many reasons why the "California premium" exists, one major reason is that refineries producing finished gasoline products for the California retail market tend to have higher production costs than other refineries.

[17] In its 2009 LCFS alternatives analysis, the CARB staff assumed that manufactures would sell more electric vehicles than required by the ZEV standards, as they existed in 2009. Vehicle manufacturer compliance with the ZEV, new vehicle GHG, and criteria emission standards is determined on a "fleet-average" basis. What this means is that to the extent that manufacturers sell more ZEVs than required, they can in turn sell greater numbers of less fuel efficient or higher emitting vehicles provided that they remain in compliance on average. In addition, manufacturers that over comply can sell "credits" to manufacturers that would not otherwise be in compliance. Therefore, even if the LCFS regulation might lead to greater demand and use of electric vehicles, there would be no net reduction in GHG emissions.

CARB has also taken and is taking a number of actions to reduce GHG emissions associated with the use of diesel fuel in heavy-duty vehicles which also need to be taken into account in the baseline for the 2014 LCFS analysis. The relevant measures include California's Tractor-Trailer regulation adopted in 2008 which requires use of aerodynamic improvement devices and low-rolling resistance tires, as well as the Phase I and the soon-to-be proposed Phase II heavy-duty GHG regulations that impose specific GHG emission requirements on new heavy-duty vehicles beginning with the 2014 model-year.[18]

B. Necessary Information for Development of a Detailed Alternative Program

In addition to properly defining the baseline for the alternatives analysis, it is important to have a clear and complete picture of the revised LCFS program that the CARB staff plans to propose. In addition to full information concerning the estimated benefits of the LCFS program (both in terms of GHG reductions and in any other relevant aspect), the currently unknown elements of that program include the following:

- Updated carbon intensity values for transportation fuels that will be included in the proposed 2014 LCFS regulation.
- The detailed form of any proposed "cost-containment" provisions which could allow parties subject to the LCFS regulation to comply with the program's standards, without actually achieving the CI reductions required under the regulation.
- CARB staff's current analysis of the manner in which regulated parties will most likely attempt to comply with the proposed 2014 LCFS.

[18] In addition to ensuring that the GHG emissions reductions associated with those regulations are properly accounted for in the baseline for the 2014 LCFS, CARB staff must also ensure that they properly account for the fact that compliance with the latter regulations is determined on a manufacturer fleet average basis in order to avoid improper assignment of GHG reductions to the 2014 LCFS regulation.

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- A full description of any other intended goals of the LCFS regulation, such as stimulating "fundamental" changes in the "transportation fuel pool," along with the metrics to be used to measure progress and success in meeting those other goals.[19]

Contrary to the position taken in the CARB staff's recent correspondence with Growth Energy and in related postings on the CARB website, none of those elements have been disclosed to the public at present. In addition to providing that undisclosed information concerning its analysis, the CARB staff should address the following other pertinent questions, which follow from the foregoing review of changes in the regulatory baseline since 2009:

- Does the CARB staff agree that the federal RFS program would, in the absence of an LCFS regulation, assure some level of reductions in GHG exhaust emissions from the California in-use vehicle population that is operated on gasoline? If not, why not; and if so, what would be that level of GHG emissions reductions, on an annual or some other specific basis, if the LCFS program were to be discontinued at the end of 2015?
    - Does the staff have any disagreement with the position that the federal RFS program and the "California premium" (*see* note 15 above) would cause Midwest corn ethanol producers to continue preferentially to deliver ethanol to California, and cause the California gasoline marketing sector to blend that Midwest corn ethanol into gasoline up to the current 10 percent limit, even in the absence of the LCFS regulation? If so, what are the specific reasons why the staff disagrees?
    - Does the staff believe that the LCFS regulation would result in wider usage of E85 in California than the federal RFS program would cause, and if so, what is the empirical basis for that view?
    - Would a possible need for a diesel component to an LCFS program justify an unnecessary gasoline component for an LCFS program, and if so, why?
- The 2009 regulatory analysis predicted that ultra-low-CI fuels would be available and would bring the costs of the LCFS program down to the point where the program would be cost-neutral at the consumer level, or would result in savings of up to $11 billion.[20]

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[19] *See* Air Resources Board, *California's Low Carbon Fuel Standard -- Final Statement of Reasons* (hereinafter "FSOR") 24.

[20] *See* ISOR at ES-26.

Does that remain the CARB staff's position? If not, what will be the consumer costs of the staff's proposed revised LCFS regulation, predicted annually or in some other manner? What uncertainties and assumptions affect those cost estimates?

- Are the ACC program and other vehicle-based GHG reduction programs adopted to implement AB 32 designed to obtain, and will they obtain, the maximum technologically feasible and cost effective reductions in GHG emissions from the new vehicles that are subject to those standards? (*See, e.g.*, Cal. Health & Safety Code § 38562(a).) If not, why not? With the ACC program and other non-LCFS regulations discussed above in Part II. A. now in place, would the LCFS program actually produce any incremental increase in the displacement of liquid motor vehicle fuels by electricity in ZEVs or hybrid electric vehicles or hydrogen in fuel cell vehicles? If so, what are the relevant increases, and on what assumptions do the predicted increases depend? Why would a vehicle manufacturer that over-achieved the ZEV requirement not use the credit gained from the overachievement by selling a higher-emitting conventional vehicle fleet? To what extent would the staff attribute to the LCFS program any displacement of vehicle miles traveled in conventional vehicles by vehicles powered by fuel cells, and what is the basis for that prediction?

- The CARB staff sometimes refers to Executive Order S-07-01 as a basis for maintaining the LCFS regulation. Should the requirements of Executive Order S-07-01 be reconsidered in the current rulemaking process insofar as the Executive Order called for creation of the LCFS regulation? Does Executive Order S-07-01 limit in any way CARB's discretion in adopting and enforcing measures to implement AB 32? Does AB 32 require adoption and enforcement of the LCFS regulation, if the same GHG reductions that the LCFS regulation can achieve could be achieved by other means?

- To the extent that the LCFS program is still intended to stimulate "fundamental changes in the transportation fuel pool" in California,[21] to what extent had the program succeeded in its first five years? Is achieving that objective consistent with the potential "cost reduction" mechanisms under consideration for a revised LCFS regulation? How should the Department and the public try to weigh that objective against the potential costs for California consumers and businesses in meeting that objective?

Having now presented the above questions to the CARB staff, Growth Energy believes that the staff should address them in the SRIA for the Department, or concurrently in a separate submittal to the Department made available to the public, if the staff does not intend otherwise to respond to those questions. Each question bears on the need for the LCFS regulation, the costs and benefits of the LCFS regulation, or the legal authority that would limit the analysis of regulatory

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[21] *See* note 19 above.

alternatives. If the CARB staff does not believe that one or more of the above questions are relevant to the evaluation of regulatory alternatives, Growth Energy requests that the CARB staff explain why, with respect to each such question.

III. Regulatory Alternatives

The CARB regulations adopted since 2009 and the federal RFS program adequately provide for full control of the direct GHG emissions from the California vehicle fleet that the LCFS regulation may have been intended to control. In 2009, CARB claimed that the LCFS regulation would provide additional GHG reductions on a lifecycle basis; the "upstream" component of the GHG benefits attributed to the LCFS regulation in 2009 was 7 MMTCO2eq in 2020.[22]

Putting to one side the question whether CARB has legal authority to adopt and enforce a regulation to control GHG emissions occurring outside California, there are several reasons to question whether the LCFS regulation actually achieves any reduction in upstream emissions. As CARB has recognized, the LCFS regulation has to date caused "fuel shuffling" -- ethanol that might have been sold in California prior to the LCFS regulation is still being produced, and is sold somewhere else.[23] Ethanol production processes and pathways that have putatively higher upstream emissions have, at this point, neither terminated nor curtailed operations as a result of the LCFS regulation.[24] In addition, many Midwest corn ethanol biorefineries have qualified for

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22 *See* ISOR at VII-1.

23 *See* FSOR at 477 ("Without the wider adoption of fuel carbon-intensity standards, fuel producers are free to ship lower-carbon-intensity fuels to areas with such standards, while shipping higher-carbon-intensity fuels elsewhere. The end result of this fuel 'shuffling' process is little or no net change in fuel carbon-intensity on a global scale.") The "wider adoption" of LCFS-type standards to which CARB referred in the 2009 FSOR has not occurred.

24 That is not to say, however, that the LCFS regulation is not injurious to the national market in ethanol, nor neutral in its impact on lifecycle GHG emissions. By causing fuel shuffling, the LCFS regulation disrupts the national market in ethanol, imposes costs, and increases transportation-related GHG emissions. Eventually, by effectively banning Midwest corn ethanol from California (if, for example, the LCFS for 2015 established in

lower-carbon-intensity LCFS "pathways" since 2009, on a scale that the CARB staff has admitted was "not expected in 2009."[25] Moreover, the estimates of upstream emissions attributed to Midwest corn ethanol in 2009 were grossly inflated: no one, including CARB, is still prepared to defend the indirect land-use change emissions factors accepted by CARB in 2009, and the current literature demonstrates that the "science" of indirect land-use change is too unreliable to be used as a basis for regulation.[26]

To the extent there is any remaining basis for attributing upstream GHG emissions reduction benefits to the LCFS regulation, those benefits certainly do not warrant the continuation or re-adoption of the LCFS regulation. The more efficient approach would be to adjust the cap-and-trade regulation in Title 17 of the *California Code of Regulations* to account for whatever increment of GHG emissions reductions would be forgone by eliminating the LCFS regulation.[27] To the extent necessary, modifications to the cap-and-trade regulation would be

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2009 were to be enforced), the LCFS regulation will leave California with no commercially viable method of complying with the standard; the staff appears to recognize this problem to some extent, with the currently ill-defined "cost reduction" features that it plans to propose. *See* Air Resources Board, *Low Carbon Fuel Standard Re-Adoption Concept Paper* (March 2014) at 6-7. The reduction in nationwide demand for Midwest corn ethanol will then also impose serious economic harm on the Midwest ethanol industry.

[25] *See* 2011 Program Review at 169. The Midwest ethanol production facilities that have qualified for lower-carbon-intensity LCFS pathways have not done so through modifications in their production processes intended to obtain those special LCFS pathways: they have a competitive incentive to increase efficiency, and would have done increased their efficiency in the absence of the LCFS regulation. A Growth Energy member has demonstrated this point in the ongoing *Rocky Mountain* litigation involving some aspects of the LCFS regulation. *See* Declaration of Erin Heupel, P.E. (included here as Attachment 6) ¶¶ 5-6. Notably, in the *Rocky Mountain* litigation, CARB offered no competent evidence to the contrary. As Ms. Heupel also demonstrated, the specific features of the LCFS regulation will eventually force even the highest-efficiency Midwest corn production facilities out of the California market. *See id.* ¶¶ 9-11.

[26] The CARB staff has begun to revise and to reduce the indirect land-use change emission factors that were included in the 2009 LCFS regulation. *See* letter from G. Cooper to K. Sideco, April 9, 2014, available at http://www.arb.ca.gov/fuels/lcfs/regamend14/rfa_04092014.pdf. It remains Growth Energy's position that the modeling methods used by CARB to generate indirect land-use change values are too unreliable for use in a regulation intended to comply with AB 32. *See* Letter from D. Bearden to J. Goldstene, May 10, 2010 (included here as Attachment 4).

[27] In 2009, CARB received substantial comments on the relative inefficiency of the LCFS approach from one of its independent peer reviewers, who urged that CARB consider a cap-and-trade alternative. *See*, e.g., FSOR at 24 (review by Dr. John Reilly); *see also id.* (summarizing Dr. Reilly's review as stating, "The economic analysis

simple and straightforward. Initially, CARB should determine what, if any, upstream GHG reductions should be attributable to the LCFS regulation, using a scientifically reliable process. CARB would also need an appropriate estimate of the total GHG emissions expected from the use of gasoline and diesel fuel in 2020. A CARB emissions forecast prepared in 2010[28] indicates that total GHG emissions from gasoline and diesel fuel use in California are expected to be approximately 175 million metric tons in 2020 under business as usual conditions. Assuming that the generally required 22 percent reduction in emissions in 2020 under the cap-and-trade program[29] applies to gasoline and diesel fuel use, total 2020 emissions without the LCFS program would be about 135 million metric tons.

Continuing the analysis, and by way of example, suppose that the cap-and-trade regulation had to cover the entire annual 16 MMTCO2eq of GHG emissions that the CARB staff identified as the benefit of the LCFS regulation for 2020. That level of GHG control could be achieved by amending the cap-and-trade regulations to require providers of gasoline and diesel fuel to submit 151 (135+16) million metric tons of allowances – or in other words requiring gasoline and diesel fuel suppliers to surrender 1.11 (151/136) allowances for every ton of GHG emissions they report from the fuels they supply.[30]

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[for the LCFS regulation] was done incorrectly. It does not meet [the] technical standards of economics. The baseline assumptions are mutually inconsistent, and if these assumptions were executed in a proper model it would show that the LCS was unnecessary.") CARB stated in 2009 that it would consider the role of cap-and-trade further in addressing the objectives of the LCFS program once the cap-and-trade regulations were completed. *See* FSOR at 452.

[28] *See* Air Resources Board, "California GHG Emissions -- Forecast 2008-2020 (updated Oct. 28, 2010), available at http://www.arb.ca.gov/cc/inventory/data/tables/2020_ghg_emissions_forecast_2010-10-28.pdf

[29] This is based on the general percentage reduction requirements established by CARB for total allowances issued. *See* Air Resources Board, "Overview of ARB Emissions Trading Program (October 2011), available at http://www.arb.ca.gov/newsrel/2011/cap_trade_overview.pdf

[30] The cap-and-trade regulation already begins to take effect for the gasoline and diesel fuel marketing sector in 2015.

The modifications to the existing text of the cap-and-trade regulation would be minor and limited to section 95852(d) of the regulation.[31] Further, the CARB staff at its discretion could also create a compliance offset program in order to incentivize low- carbon intensity fuels similar to those in place which incentivize other innovative GHG reduction strategies.[32] Insofar as one goal of the APA is to eliminate unnecessary regulation, this approach would well-serve the goals

[31] Thus, the text of section 95852(d), with the modification shown in italics, and assuming that the full 10 percent GHG emission reduction attributed to the LCFS regulation would be covered by cap-and-trade, would provide as follows:

> Suppliers of RBOB and Distillate Fuel Oils. A supplier of petroleum products covered under sections 95811(d) or 95812(d) has a compliance obligation *equal to 1.x allowances* for every metric ton CO_2e of GHG emissions included in an emissions data report that has received a positive or qualified positive emissions data verification statement or for which emissions have been assigned that would result from full combustion or oxidation of the quantities of the following fuels that are removed from the rack in California, sold to entities not licensed by the California Board of Equalization as a fuel supplier, or imported into California and not directly delivered to the bulk-transfer/terminal system as defined in section 95102 of MRR, except for products for which a final destination outside California can be demonstrated:
>
> (1) RBOB;
> (2) Distillate Fuel Oil No. 1; and
> (3) Distillate Fuel Oil No. 2.
>
> *The value of "x" above will be established by Executive Officer by the prior October 31 for each year beginning with 2015 to ensure that actual GHG emissions from the use of RBOB and Distillate Fuel Oil No. 1 and Distillate Fuel Oil No. 2 are reduced to the level that would have been achieved had the Carbon Intensity of those fuels been reduced according to the following schedule relative to 2010.*

Required Carbon Intensity Reduction Relative to 2010	
Year	Reduction
2015	2.7%
2016	3.7%
2017	5.2%
2018	6.7%
2019	8.2%
2020	10.0%

As illustrated above for 2020, the value of "x" would be 0.11 and the compliance obligation for suppliers of gasoline and diesel fuels would be 1.11 times the number of tons of CO_2e emissions reported.

[32] *See* Air Resources Board, "Climate Change Programs -- Compliance Offset Program" (updated June 11, 2014), available at http://www.arb.ca.gov/cc/capandtrade/offsets/offsets.htm

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of the APA. By eliminating the LCFS regulation, CARB would also free the California transportation fuel sector from continuing uncertainty about the availability and cost of ultra-low-carbon-intensity alternative fuels necessary for future compliance with the LCFS. As the Western States Petroleum Association ("WSPA") has stated:

> The LCFS, as envisioned by Governor Schwarzenegger in his Executive Order and as developed by the ARB, is infeasible. ... [S]taying the course now could result in disruptions in the transportation fuels markets. ... A successful fuels policy must protect against fuel supply disruptions, severe job losses in the state's refining industry and unacceptable economic harm to California and its citizens.[33]

While Growth Energy believes that its proposal has sufficient merit without endorsement by other organizations, the concerns expressed by WSPA are important. One benefit of the change that Growth Energy is proposing, and a benefit that is particularly important to Growth Energy and the enterprises it represents, is that elimination of the LCFS regulation would eliminate a major conflict between regulations adopted by California and the federal RFS program, a conflict that will only increase if the LCFS regulation is re-adopted.

In considering Growth Energy's proposal, and in addition to the questions presented in Part II of this submittal, the CARB staff should in the SRIA address the following questions:

- The CARB staff's May 23, 2014, notice soliciting public input for the SRIA sought "alternative LCFS approaches." (See Attachment 5.) Does the CARB staff believe the alternatives analysis for the SRIA and public submittals related to the SRIA must be confined to regulatory alternatives that include or would preserve in some form the LCFS regulation? If so, what is the basis for such a limitation?

- Other than emissions created in generating electricity for delivery in California, does AB 32 give CARB the authority to regulate upstream emissions occurring outside California, or to account for upstream emissions occurring outside

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[33] The reference is to Executive Order S-01-07, with its "10 percent" by 2020 goal, which according to the CARB staff remains the target for the LCFS regulation. *See* Letter from G. Grey to K. Sideco, June 13, 2014 at 2, available at http://www.arb.ca.gov/fuels/lcfs/regamend14/wspa_06132014.pdf. WSPA has also stated that modification of the LCFS program through "cost reduction" provisions would "simply penalize fuel suppliers for not meeting an infeasible standard." *See* Letter from C. Reheis-Boyd to K. Sideco, April 11, 2014 at 10, available at http://www.arb.ca.gov/fuels/lcfs/regamend14/wspa_04112014.pdf.

California in adopting regulations to meet the statewide greenhouse gas emissions limit? (*See* Cal. Health & Safety Code § 38505(m), (n); 38562(a).) If AB 32 authorizes CARB to regulate or consider out-of-state GHG emissions attributed to ethanol production, does AB 32 also authorize CARB to address those emissions through the cap-and-trade regulation?

- Can the California cap-and-trade regulations be modified to provide the same numerical reductions in GHG emissions as the LCFS regulation? If not, why not?

- If the CARB staff is concerned that the state measures to control GHG emissions and the federal RFS program might not be fully implemented and enforced at some time in the future, would adoption of a revised LCFS regulation as a "backstop" measure, to be implemented only if those other programs are not meeting defined objectives, address that concern? If not, why not?

- If the CARB staff believes some regulated parties might prefer to comply with a revised LCFS regulation rather than a modified cap-and-trade regulation, could that issue be addressed by including a revised LCFS as a part of a regulatory alternative (with appropriate opt-in provisions) that would be an option for parties that did not wish to comply with a modified cap-and-trade regulation?

- What are the current and expected future levels of resources at CARB, in terms of personnel and other resources, that are allocated to the LCFS regulation? What would be the budgetary impact for CARB if the LCFS program were eliminated? What would be the budgetary impact for CARB caused by the change in the cap-and-trade regulation proposed here?

- To the extent the CARB staff would attribute other beneficial impacts, different from GHG emissions reductions, to the LCFS regulation, to whom do those benefits accrue? With regard to those other beneficial impacts, are California consumers benefitted and, if so, how and to what extent? With regard to those other beneficial impacts, are California businesses benefitted and if so, how and to what extent? Do those other beneficial impacts justify or support continuation of the LCFS regulation, and if so, what is the basis for CARB's authority to adopt and enforce the LCFS regulation to obtain those benefits? If those other beneficial impacts include the possibility that sources for alternative fuels will be increased or diversified, are there any peer-reviewed or other studies that support such a proposition? If not, what is the staff's basis for attributing such benefits to the LCFS regulation? Could those benefits be realized through the development of a compliance offset program under the cap-and-trade regulation?

As with the questions presented in Part II, the CARB staff's responses to these questions are important in understanding its evaluation of Growth Energy's proposal. If the CARB staff does not believe that one or more of the above questions are relevant to the evaluation of

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regulatory alternatives, Growth Energy requests that the CARB staff explain why, with respect to each such question.

IV. Next Steps

As noted at the outset of this submittal, Growth Energy's analysis of alternatives to the LCFS regulation can be no more detailed than the available information about the staff's intended revised LCFS regulation. If CARB does nothing further to facilitate the public input into the SB 617 process for use in the SRIA, it will not have substantially complied with the APA as amended by SB 617 and implemented in the Department's regulations.

In the CARB staff's first notice that it was ready to receive public input on regulatory alternatives, published on May 23, 2014, the staff set a deadline for that input of June 6, 2014 -- nine business days later. The staff indicated in that notice that the public should, among other things, "submit the quantities of low-CI fuels used each year" in the proposed alternative to the LCFS regulation, "as well as the associated cost and benefit information, and their sources." [34] According to the May 23 notice, that information was needed "to enable comparison of economic impacts."[35] The May 23 notice stated that the objective for public input should be to provide "alternative LCFS approaches," meaning "any approach that may yield the same or greater benefits than those associated with the proposed regulation, or that may achieve the goals at lower cost."[36]

The "proposed regulation" to which the May 23 proposal referred (i) had not been provided to the public for review as of May 23, nor (ii) has it been provided at any time since

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[34] *See* Attachment 5.

[35] *Id.*

[36] *Id.*

May 23.[37] The May 23 notice was not accompanied by any information that provided the CARB staff's own prediction of "the quantities of low-CI fuels [that would be] used each year" under the CARB staff's proposed regulation, nor the benefits that the CARB staff attributed to the LCFS regulation. Growth Energy requested that the CARB staff give the public the information needed to prepare a complete SB 617 submission and requested that the public be given additional time to prepare SB 617 analyses after the necessary information was released.[38]

The CARB staff responded by extending the deadline for public submittals that would be addressed in the SRIA to June 23, 2014 (31 days after the May 23 notice), but did not provide any of the information requested by Growth Energy and needed to provide the type of input sought in the May 23 notice, and necessary under the Department's SB 617 regulations. Instead, the staff referred to the GHG emissions reductions targeted in the 2009 rulemaking, to a March 2014 "Concept Paper" that discussed the staff's approach to revision of the LCFS regulation, and to material provided to the public in connection with regulatory workshops held in ARB's offices.[39] The March 2014 Concept Paper raises more questions about the staff's approach than it answers: it included, for example, a general description of two different "cost reduction" concepts without indicating how either of them would work, how they would reduce costs, or how they would affect the GHG emissions reduction benefits of the LCFS program. If the March 2014 Concept Paper provided a basis for preparing SB 617 submittals, then there is no reason why the CARB staff should have waited until May 23 to solicit public input under the Department's regulations. Had the staff informed the public when it released the Concept Paper

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[37] The CARB staff has released some draft regulatory text for their proposed revised LCFS, but that partial text does not include, for example, the "cost reduction" feature intended for the new regulation, nor the carbon intensity values to be assigned to each alternative fuel.

[38] *See* Attachment 1.

[39] *See* Attachment 2.

and discussed the Concept Paper at one of its March 2014 regulatory workshops that the Concept Paper was intended to provide a basis for SB 617 input, Growth Energy (and perhaps other stakeholders) would have pointed out at that time that the Concept Paper was inadequate for that purpose; in that event, perhaps the CARB staff would have been able to provide the necessary information for public input into the SRIA.

The materials provided in connection with the regulatory workshops -- including the partial regulatory text released on May 28, after the staff had launched the public input process -- likewise do not provide the necessary information for detailed public submittals consistent with SB 617 and the Department's regulations. Growth Energy has studied those materials carefully, and with the greatest respect, would challenge the CARB staff to indicate where in those materials the staff identifies GHG emissions reduction targets for a revised LCFS regulation; where the staff identifies any other putative benefits of the LCFS regulation; and where in those materials the staff provides specific and concrete information about the impact of the "cost reduction" concepts on the quantities of alternative fuels that would be used in order to comply with the revised LCFS regulation, or permits a quantification of costs and benefits of a revised LCFS regulation that includes a cost-reduction feature.

Finally, it is important to address comments by the CARB staff at one recent workshop, which suggested that the timing of the current regulatory effort has been affected by the Board's need to comply with the mandate in litigation under the APA and the California Environmental Quality Act ("CEQA").[40] In that litigation, the Superior Court has allowed CARB all the time

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[40] The case is *POET LLC et al. v. California Air Resources Board*, Case No. 09 CE CG 04659 (Sup'r Ct., Fresno County). The Writ of Mandate in that proceeding does not require CARB to commence or conclude rulemaking by a particular date, but to proceed in good faith without delay. The Writ of Mandate was issued more than six months ago, by which time CARB presumably knew that it had to comply with the Department's SB 617 regulations.

that the Board has requested in order to comply with the mandate. If CARB needs more time in order to conduct the SB 617 process in a manner that allows sufficient time for effective public input into the preparation of an SRIA, CARB should so inform the Superior Court. (Notably, in its filings with the Superior Court, CARB has not adverted to SB 617 or the Department's implementing regulations.) In addition, the CARB staff would surely agree that even before issuance of the mandate in that litigation, it was aware that it had major program review obligations for the LCFS regulation in 2014.[41] Particularly in light of those program review obligations, the CARB staff's inability to provide more information now to the public, needed to participate fully in the SB 617 process, seems inexcusable.

Against that backdrop, Growth Energy urges the CARB staff to reconsider its present approach to the SB 617 process, and specifically the staff's approach to obtaining public input for the SRIA. As the staff might expect, if one response to Growth Energy's proposed regulatory

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[41] In 2009, when it first adopted the LCFS regulation, the Board directed the CARB staff to conduct and to present by January 1, 2015 a "review of implementation of the LCFS program" that was to "include, at a minimum, consideration of the following areas:

> "(1) The LCFS program's progress against LCFS targets;
> "(2) Adjustments to the compliance schedule, if needed;
> "(3) Advances in full, fuel-lifecycle assessments;
> "(4) Advances in fuels and production technologies, including the feasibility and cost-effectiveness of such advances;
> "(5) The availability and use of ultralow carbon fuels to achieve the LCFS standards and advisability of establishing additional mechanisms to incentivize higher volumes of these fuels to be used;
> "(6) An assessment of supply availabilities and the rates of commercialization of fuels and vehicles;
> "(7) The LCFS program's impact on the State's fuel supplies;
> "(8) The LCFS program's impact on state revenues, consumers, and economic growth;
> ...
> "(12) Significant economic issues; fuel adequacy, reliability, and supply issues; and environmental issues that have arisen; and
> "(13) The advisability of harmonizing with international, federal, regional, and state LCFS and lifecycle assessments."
>
> 17 C.C.R. § 95489(a).

alternative is that Growth Energy's proposal lacks a detailed comparison with the costs, benefits, and cost-effectiveness of the staff's proposal in the SRIA, Growth Energy will attribute its lack of specificity to the staff's failure to provide the information needed to offer a more specific regulatory analysis. Because this is one of the first major rulemakings at CARB that is required to comply with SB 617 and the Department's SB 617 regulations, it is also important for the Department to take a proactive role in providing guidance to CARB, the stakeholders, and other members of the public interested in the LCFS program.

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Respectfully submitted,

GROWTH ENERGY

3_B_ADF_GE Responses (Page 377 – 404)

233. Comment: **Response to Request for Public Input on Alternatives to the Low Carbon Fuel Standard Regulation June 23, 2014**

Agency Response:
This is the second time this document was submitted by Growth Energy. It is a reproduction of comments **LCFS 46-195** through **LCFS 46-232**. See responses to these comments above.

NOx Emissions Impact of Soy- and Animal-based Biodiesel Fuels: A Re-Analysis

December 10, 2013

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NOX EMISSIONS IMPACT OF SOY- AND ANIMAL-BASED BIODIESEL FUELS: A RE-ANALYSIS

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NOX IMPACT OF SOY- AND ANIMAL-BASED BIODIESEL FUELS: A RE-ANALYSIS

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1. EXECUTIVE SUMMARY

1.1 Background on the Proposed Rule

The California Air Resources Board (CARB) has proposed regulations on the commercialization of alternative diesel fuel (ADF) that were to be heard at the December 2013 meeting of the Board. The proposed regulations seek to "... create a streamlined legal framework that protects California's residents and environment while allowing innovative ADFs to enter the commercial market as efficiently is possible."[1] In this context ADF refers to biodiesel fuel blends. Biodiesel fuels are generally recognized to have the potential to decrease emissions of several pollutants, including hydrocarbons (HC), carbon monoxide (CO), and particulate matter (PM), but are also recognized to have the potential to increase oxides of nitrogen (NOx) unless mitigated in some way. NOx emissions are an important precursor to smog and have historically been subject to stringent emission standards and mitigation programs to prevent growth in emissions over time. A crucial issue with respect to biodiesel is how to "... safeguard against potential increases in oxides of nitrogen (NOx) emissions."[2]

The proposed regulations are presented in the Staff Report: Initial Statement of Reasons (ISOR) for the Proposed Regulation on the Commercialization of New Alternative Diesel Fuels[3] (referenced as ISOR). Chapter 5 of the document describes the proposed regulations, which exempt diesel blends with less than 10 percent biodiesel (B10) from requirements to mitigate NOx emissions:

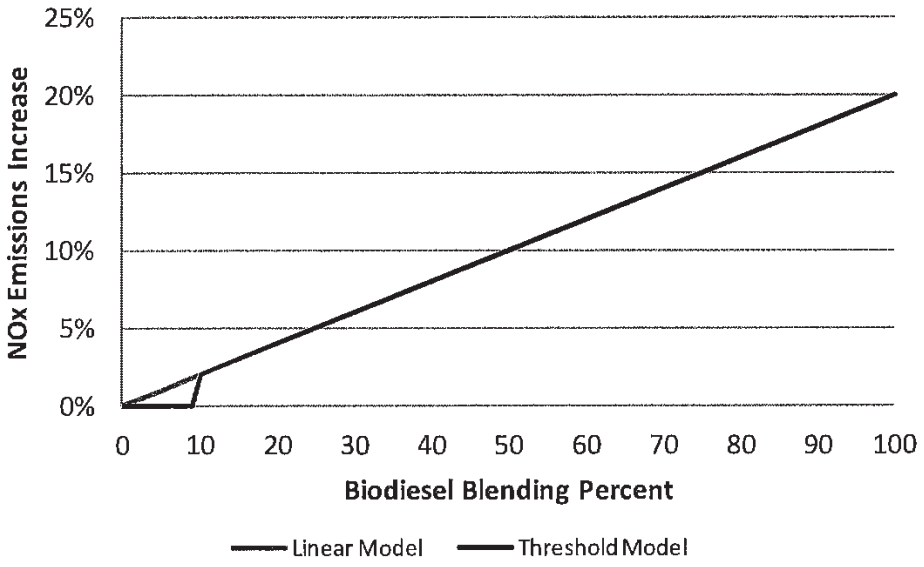
> There are two distinct blend levels relative to biodiesel that have been identified as important for this analysis. Based on our analysis to date, we have found that diesel blends with less than 10 percent biodiesel by volume (<B10) have no significant increase in any of the pollutants of concern and therefore will be regulated at Stage 3B (Commercial Sales not Subject to Mitigation). However, we have found that biodiesel blends of 10 percent and above (≥B10) have potentially significant increases in NOx emissions, in the absence of any mitigating factors, and therefore those higher blend levels will be regulated under Stage 3A (Commercial Sales Subject to Mitigation).[4]

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[1] "Notice of Public Hearing to Consider Proposed Regulation on the Commercialization of New Alternative Diesel Fuels." California Air Resources Board, p. 3. http://www.arb.ca.gov/regact/2013/adf2013/adf2013notice.pdf.
[2] Ibid. p. 3.
[3] "Proposed Regulation on the Commercialization of New Alternative Diesel Fuels. Staff Report: Initial Statement of Reason." California Air Resources Board, Stationary Source Division, Alternative Fuels Branch. October 23, 2013. http://www.arb.ca.gov/regact/2013/adf2013/adf2013isor.pdf.
[4] Ibid, p. 22.

Existing research on the NOx emission effects of biodiesel has consistently been conducted under the hypothesis that the emission effect will be linearly proportional to the blending percent of neat biodiesel (B100) with the base diesel fuel. The Linear Model that has been accepted by researchers is shown as the blue line in Figure 1-1. The Staff position cited above is that biodiesel fuels do not increase NOx emissions until the fuel blend reaches 10% biodiesel. This so-called Staff Threshold Model departs from the Linear Model that underlies past and current biodiesel research by claiming that NOx emissions do not increase until the biodiesel content reaches 10 percent.

Figure 1-1
Linear and Staff Threshold Models for Biodiesel NOx Impacts



The Staff Threshold model is justified by the statement: "Based on our analysis to date, we have found that diesel blends with less than 10 percent biodiesel by volume (<B10) have no significant increase in any of the pollutants of concern." Other portions of the ISOR state that Staff will track "... the effective blend level on an annual statewide average basis until the effective blend level reaches 9.5 percent. At that point, the biodiesel producers, importers, blenders, and other suppliers are put on notice that the effective blend-level trigger of 9.5 percent is approaching and mitigation measures will be required once the trigger is reached."[5] Until such time, NOx emission increases from biodiesel blends below B10 will not require mitigation.

Section 6 of the ISOR presents a Technology Assessment that includes a literature search the Staff conducted to obtain past studies on the NOx impact of biodiesel in heavy-duty

[5] Ibid, p. 24.

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engines using California diesel (or other high-cetane diesel) as a base fuel. Section 6.d presents the results of the literature search with additional technical information provided in Appendix B. The past studies include the Biodiesel Characterization and NOx Mitigation Study[6] sponsored by CARB (referenced as Durbin 2011).

The results of the Staff literature search are summarized in Table 1-1, which has been reproduced from Table 6.1 of the ISOR. For B5 and B20, the data represent averages for a mix of soy- and animal-based biodiesels, which tend to have different impacts on NOx emissions (animal-based biodiesels increase NOx to a lesser extent). For B10, the data represent an average for soy-based biodiesels only. Staff uses the +0.3% average NOx increase at B5 in comparison to the 1.3% standard deviation to conclude:

> Overall, the testing indicates different NOx impacts at different biodiesel percentages. Staff analysis shows there is a wide statistical variance in NOx emissions at biodiesel levels of B5, providing no demonstrable NOx emissions impact at this level and below. At biodiesel levels of B10 and above, multiple studies demonstrate statistically significant NOx increases, without additional mitigation.[7]

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Table 1-1
Results of Literature Search Analysis

Biodiesel Blend Level	NOx Difference	Standard Deviation
B5	0.3%	1.3%
B10[a]	2.7%	0.2%
B20	3.2%	2.3%

Source: Table 6.1 of Durbin 2011
Notes:
[a] Represents data using biodiesel from soy feedstocks.

The Staff conclusion is erroneous because it relies upon an apples-to-oranges comparison among the blending levels. Each of the B5, B10, and B20 levels include data from a different mix of studies, involving different fuels (soy- and/or animal-based), different test engines, and different test cycles. The B5 values come solely from the CARB Biodiesel Characterization study, while the B10 values come solely from other studies. The B20 values are a mix of data from the CARB and other studies. The results seen in the table above are the product of the uncontrolled aggregation of different studies that produces incomparable estimates of the NOx emission impact at the three blending levels.

[6] "CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California: Biodiesel Characterization and NOx Mitigation Study." Prepared by Thomas D. Durbin, J. Wayne Miller and others. Prepared for Robert Okamoto and Alexander Mitchell, California Air Resources Board. October 2011.
[7] ISOR, p. 32.

As will be demonstrated in this report, the Staff conclusion drawn from the data in Table 1-1 is not supported by past or current biodiesel research, including the recent testing program sponsored by CARB. In fact, past and current studies indicate that biodiesel blends at any level will increase NOx emissions in proportion to the blending percent unless specifically mitigated by additives or other measures.

1.2 Summary and Conclusions

The following sections of this report examine the studies cited by CARB one-by-one. As evidenced from this review, it is clear that the data do not support the Staff conclusion and, indeed, the data refute the Staff conclusion in some instances. Specifically:

- There is no evidence supporting the Staff conclusion that NOx emissions do not increase until the B10 level is reached. Instead, there is consistent and strong evidence that biodiesel increases NOx emissions in proportion to the biodiesel blending percent.

- There is clear and statistically significant evidence that biodiesel increases NOx emissions at the B5 level in at least some engines for both soy- and animal-based biodiesels.

Considering each of the six past studies obtained from the technical literature and their data on high-cetane biodiesels comparable to California fuels, we find the following:

1. None of the six studies measured the NOx emissions impact from biodiesel at blending levels below B10. Only two studies tested a fuel at the B10 level. All other testing was at the B20 level or higher. Because none tested a B5 (or similar) fuel, none of them can provide direct evidence that NOx emissions are not increased at B5 or other blending levels below B10.

2. These studies provide no data or evidence supporting the validity of the Staff's Threshold Model that biodiesel below B10 does not increase NOx emissions. In fact, all of the studies are consistent with the contention that biodiesel increases NOx emissions in proportion to the blending percent.

3. Two of the studies present evidence and arguments that the NOx impact from biodiesel is a continuous effect that is present even at very low blending levels and will increase at higher levels in proportion to the blending percentage.

Considering the CARB Biodiesel Characterization report, we find that:

4. For the three engines where CARB has published the emission values measured in engine dynamometer testing, all of the data demonstrate that biodiesel fuels significantly increase NOx emissions for both soy- and animal-based fuels by amounts that are proportional to the blending percent. This is true for on-road and off-road engines and for a range of test cycles.

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5. Where B5 fuels were tested for these engines, NOx emissions were observed to increase. NOx emission increases are smaller at B5 than at higher blending levels and the observed increases for two engines were not statistically significant by themselves based on the pair-wise t-test employed in Durbin 2011.[8] However, the testing for one of the engines (the 2007 MBE4000) showed statistically significant NOx emission increases at the B5 level for both soy- and animal-based blends.

By itself, the latter result is sufficient to disprove the Staff's contention that biodiesel blends at the B5 level will not increase NOx emissions.

Based on examination of all of the studies cited by CARB as the basis for its proposal to exempt biodiesels below B10 from mitigation, it is clear that the available research points to the expectation that both soy- and animal-based biodiesel blends will increase NOx emissions in proportion to their biodiesel content, including at the B5 level. CARB's own test data demonstrate that B5 will significantly increase NOx emissions in at least some engines.

Based on data in the CARB Biodiesel Characterization report, soy-based biodiesels will increase NOx emissions by about 1% at B5 (and 2% at B10), while animal-based biodiesels will increase NOx emissions by about one-half as much: 0.45% at B5 (and 0.9% at B10). All of the available research says that the NOx increases are real and implementation of mitigation measures will be required to prevent increases in NOx emissions due to biodiesel use at blending levels below B10.

Finally, we note that CARB has not published fully the biodiesel testing data that it relied on in support of the Proposed Rule and thereby has failed to adequately serve the interest of full public disclosure in this matter. The CARB-sponsored testing reported in Durbin 2011 is the sole source of B5 testing cited by CARB as support for the Proposed Rule. Durbin 2011 publishes only portions of the measured emissions data in a form that permits re-analysis; it does not publish any of the B5 data in such a form. It has not been possible to obtain the remaining data through a personal request to Durbin or an official public records request to CARB and, to the best of our knowledge, the data are not otherwise available online or through another source.

CARB should publish all of the testing presented in Durbin 2011 and any future testing that it sponsors in a complete format that allows for re-analysis. Such a format would be (a) the measured emission values for each individual test replication; or (b) averages across all test replications, along with the number of replications and the standard error of the individual tests. The first format (individual test replications) is preferable because that would permit a full examination of the data including effects such as test cell drift over time. Such publication is necessary to assure that full public disclosure is achieved and that future proposed rules are fully and adequately informed by the data.

[8]As discussed in Section 3.3, the pair-wise t-test is not the preferred method for demonstrating statistical significance.

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1.3 Review of 2013 CARB B5 Emission Testing

In December 2013, after the release of the ISOR and in response to an earlier Public Records Act request, CARB released a copy of new CARB-sponsored emission testing conducted by Durbin and others at the University of California CE-CERT[9]. The purpose of the study was "... to evaluate different B5 blends as potential emissions equivalent biodiesel fuel formulations for California."[10] Three B5 blends derived from soy, waste vegetable oil (WVO), and animal biodiesel stocks were tested on one 2006 Cummins ISM 370 engine using the hot-start EPA heavy-duty engine dynamometer cycle. A preliminary round of testing was conducted for all three fuels followed by emissions-equivalent certification testing per 13 CCR 2282(g) for two of the fuels. As noted by Durbin: "[t]he emissions equivalent diesel certification procedure is robust in that it requires at least twenty replicate tests on the reference and candidate fuels, providing the ability to differentiate small differences in emissions."[11]

Soy and WVO B5 Biodiesel

The B5-soy and B5-WVO fuels were blended from biodiesel stocks that were generally similar to the soy-based stock used in the earlier CARB Biodiesel Characterization Study (Durbin 2011) with respect to API gravity and cetane number. In the preliminary testing, the two fuels "...showed 1.2-1.3% statistically significant [NOx emissions] increases with the B5-soy and B5-WVO biodiesel blends compared to the CARB reference fuel."[12] The B5-WVO fuel caused the smaller NOx increase (1.2%) and was selected for the certification phase of the testing. There, it "... showed a statistically significant 1.0% increase in NOx compared to the CARB reference fuel"[13] and failed the emissions-equivalent certification due to NOx emissions.

Animal B5 Biodiesel

The B5-animal derived fuel was blended from an animal tallow derived biodiesel that was substantially different from the animal based biodiesel used in the earlier Durbin study, and was higher in both API gravity and cetane number. The blending response for cetane number was also surprising, in that blending 5 percent by volume of a B100 stock (cetane number 61.1) with 95% of CARB ULSD (cetane number 53.1) produced a B5 fuel blend with cetane number 61.

In preliminary testing, the B5-animal fuel showed a small NOx increase which was not statistically significant, causing it to be judged the best candidate for emissions-equivalent certification. In the certification testing, it "...showed a statistically

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[9] "CARBB5 Biodiesel Preliminary and Certification Testing." Prepared by Thomas D. Durbin, G. Karavalakis and others. Prepared for Alexander Mitchell, California Air Resources Board. July 2013. This study is not referenced in the ISOR, nor was it included in the rule making file when the hearing notice for the ADF regulation was published in October 2013.
[10] Ibid, p. vi.
[11] Ibid, p. viii.
[12] Ibid, p. 8.
[13] Ibid, p. 9.

significant 0.5% reduction in NOx compared to the CARB reference fuel"[13] and passed the emissions-equivalent certification. The NOx emission reduction for this fuel blend appears to be real for this engine, but given the differences between the blendstock and the animal based biodiesel blendstock used in the earlier Durbin study it is unclear that it is representative for animal-based biodiesels in general..

Summary

The conclusions drawn in the preceding section are not changed by the consideration of these new emission testing results. For plant-based biodiesels (soy- and WVO-based), the new testing provides additional and statistically significant evidence that B5 blends will increase NOx emissions at the B5 level. The result of decreased NOx for the B5 animal-based blend stands out from the general trend of research results reviewed in this report. However:

- The same result – reduced NOx emissions for some fuels and engines – has sometimes been observed in past research, as evidenced by the emissions data considered by CARB staff in ISOR Figure B.3 (reproduced in Figure 2.1 below). As shown, some animal-based B5 and B20 fuels reduced NOx emissions while others increased NOx emissions with the overall conclusion being that NOx emissions increase in direct proportion to biodiesel content of the blends and that there is no emissions threshold.

- Increasing cetane is known to generally reduce NOx emissions and has already been proposed by CARB as a mitigation strategy for increased NOx emissions from biodiesel[14]. The unusual cetane number response in the blending and the high cetane number of the B5-animal fuel may account for the results presented in the recently released study.

Considering the broad range of plant- and animal-based biodiesel stocks that will be used in biodiesel fuels, we conclude that the available research (including the recently released CARB test results) indicates that unrestricted biodiesel use at the B5 level will cause real increases in NOx emissions and that countermeasures may be required to prevent increases in NOx emissions due to biodiesel use at blending levels below B10.

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[14] For example, see Durbin 2011 Section 7.0 for a discussion of NOx mitigation results through blending of cetane improvers and other measures.

2. CARB LITERA TURE REVIEW

The Staff ISOR explains that the Appendix B Technology Assessment is the basis for CARB's conclusion that biodiesels below B10 have no significant impact on NOx emissions. The assessment is based on data from seven studies (identified in Table 2-1) that tested high-cetane diesel fuels. The first study (Durbin 2011) is the Biodiesel Characterization Study that was conducted for CARB, while the others were obtained through a literature search.

Tab le 2-1
List of Studies f rom High-Cetane Liter ature Sear ch

Primary Author	Title	Published	Year
Durbin	Biodiesel Mitigation Study	Final Report Prepared for Robert Okamoto, M.S. and Alexander Mitchell, CARB	2011
Clark	Transient Emissions Comparisons of Alternative Compression Ignition Fuel	SAE 1999-01-1117	1999
Eckerle	Effects of Methyl Ester Biodiesel Blends on NOx Emissions	SAE 2008-01-0078	2008
McCormick	Fuel Additive and Blending Approaches to Reducing NOx Emissions from Biodiesel	SAE 2002-01-1658	2002
McCormick	Regulated Emissions from Biodiesel Tested in Heavy-Duty Engines Meeting 2004 Emissions	SAE 2005-01-2200	2005
Nuszkowski	Evaluation of the NOx emissions from heavy duty diesel engines with the addition of cetane improvers	Proc. I Mech E Vol. 223 Part D: J. Automobile Engineering, 223, 1049-1060	2009
Thompson	Neat fuel influence on biodiesel blend emissions	Int J Engine Res Vol. 11, 61-77.	2010

Source: Table B.2 of Durbin 2011

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Figure 2-1 reproduces two exhibits from Appendix B that show increasing trends for NOx emissions with the biodiesel blending level. Based on the slopes of the trend lines,

Figure 2-1
NOx Emission Increases Observed in Biodiesel Research Cited in Staff ISOR

Figure B.2: NOx Impact of Soy Biodiesel Blended in High Cetane Base Fuel

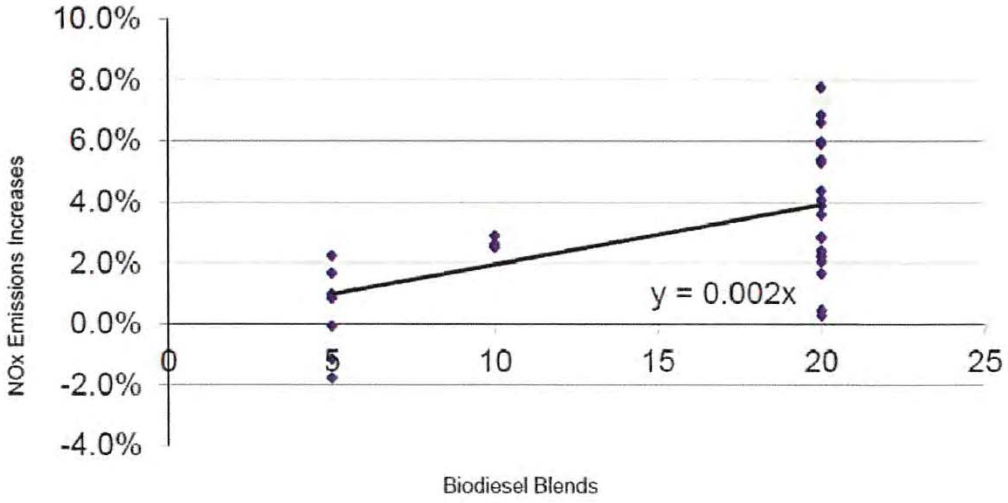
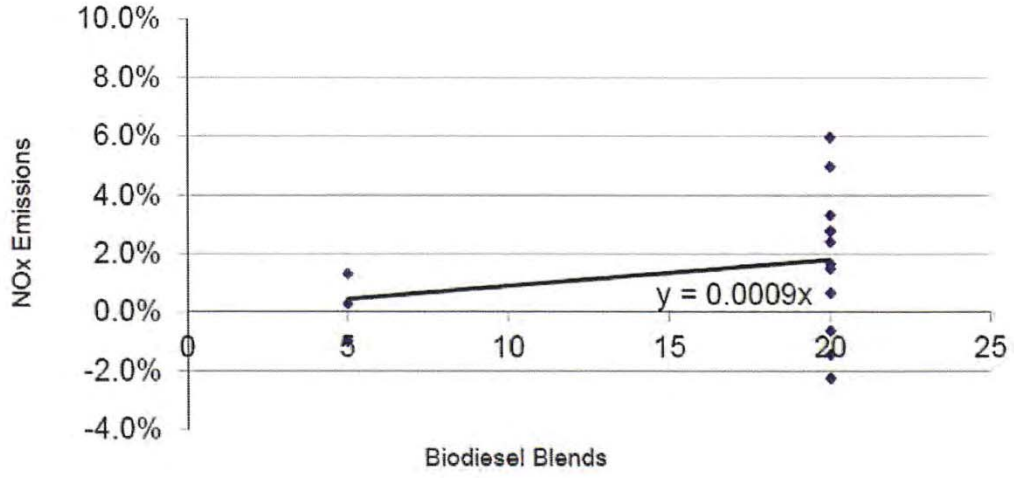


Figure B.3: NOx Impact of Animal Biodiesel Blended in High Cetane Base Fuel



Source: Figures B.2 and B.3 of Appendix B: Technology Assessment

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soy-based biodiesels are shown to increase NOx emissions by approximately 1% at B5, 2% at B10, and 4% at B20. Animal-based biodiesels are shown to increase NOx emissions by about one-half as much: 0.45% at B5, 0.9% at B10, and 1.8% at B20. Although there is substantial scatter in the results, these data do not appear to support the Staff Threshold Model that biodiesel does not increase NOx emissions at B5 but does so at B10.

We will examine the Durbin 2011 study at some length in Section 3. In this section, we look at each of the other studies cited by the Staff to find out what the studies say about NOx emissions impacts at and below B10.

2.1 Review of Literature Cited in the ISOR

The Staff literature search sought and selected testing that used fuels with cetane levels comparable to California diesel fuels; the Staff does not, however, list those fuels or provide the data that support the tables and figures in Appendix B of the ISOR. Therefore, we have necessarily made our own selection of high-cetane fuels in the course of reviewing the studies. The key testing and findings of each study are summarized below, with a specific focus on what they tell us about NOx emission impacts at B10 and below.

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2.1.1 Clark 1999

This study tested a variety of fuels on a 1994 7.3L Navistar T444E engine. Of the high-cetane base fuels, one base fuel (Diesel A, off-road LSD) was blended and tested at levels of B20, B50, and B100. NOx emissions were significantly increased for all of the blends. The other base fuel (CA Diesel) was tested only as a base fuel. Its NOx emissions were 12% below that of Diesel A, making it is unclear whether Diesel A is representative of fuels in CA. This study conducted no testing of the NOx emissions impact from biodiesels at the B10 level or below.

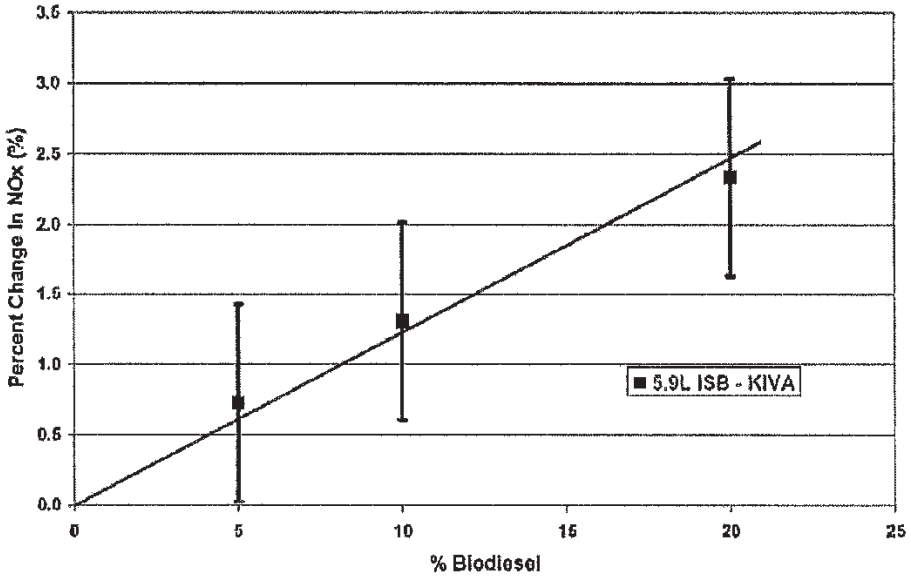
2.1.2 Eckerle 2008

This study tested low and mid/high-cetane base fuels alone and blended with soy-based biodiesel at the B20 level. The Cummins single-cylinder test engine facility was used in a configuration representative of modern diesel technology, including cooled EGR. Testing was conducted under a variety of engine speed and load conditions. FTP cycle emissions were then calculated from the speed/load data points. The test results show that B20 blends increase NOx emissions compared to both low- and high-cetane base fuels. This study conducted no testing of the NOx emissions impact from biodiesels at the B10 level or below.

The study notes that two other studies "show that NOx emissions increase nearly linearly with the increase in the percentage of biodiesel added to diesel fuel." Eckerle's Figure 21 (reproduced below as Figure 2-2) indicates a NOx emissions increase at B5, which is the basis for the statement in the abstract that "Results also show that for biodiesel blends containing less than 20% biodiesel, the NOx impact over the FTP cycle is proportional to

the blend percentage of biodiesel." The authors clearly believe that biodiesel fuels have NOx emission impacts proportional to the blending percent at all levels including B5.

Figure 2-2
Impact of Biodiesel Blends on Percent NOx Change for the 5.9L ISB Engine Operation Over the FTP Cycle



Source: Figure 21 of Eckerle 2008

2.1.3 McCormick 2002

This study tested low- and mid-cetane base fuels alone and blended with soy- and animal-based biodiesel at the B20 level. The testing was conducted on a 1991 DDC Series 60 engine using the hot-start U.S. heavy-duty FTP. NOx emission increases were observed for both fuels at the B20 level. Mitigation of NOx impacts was investigated by blending a Fisher-Tropsch fuel, a 10% aromatics fuel and fuel additives. This study conducted no testing of the NOx emissions impact from commercial biodiesels at the B10 level or below.

This study also tested a Fisher-Tropsch (FT) base fuel blended at the B1, B20, and B80 levels. Although the very high cetane number (≥75) takes it out of the range of commercial diesel fuels, it is interesting to note that the study measured higher NOx emissions at the B1 level than it did on the FT base fuel and substantially higher NOx emissions at the B20 and B80 levels. While the B1 increase was not statistically significant given the uncertainties in the emission measurements (averages of three test runs), it is clear that increased NOx emissions have been observed at very low blending levels.

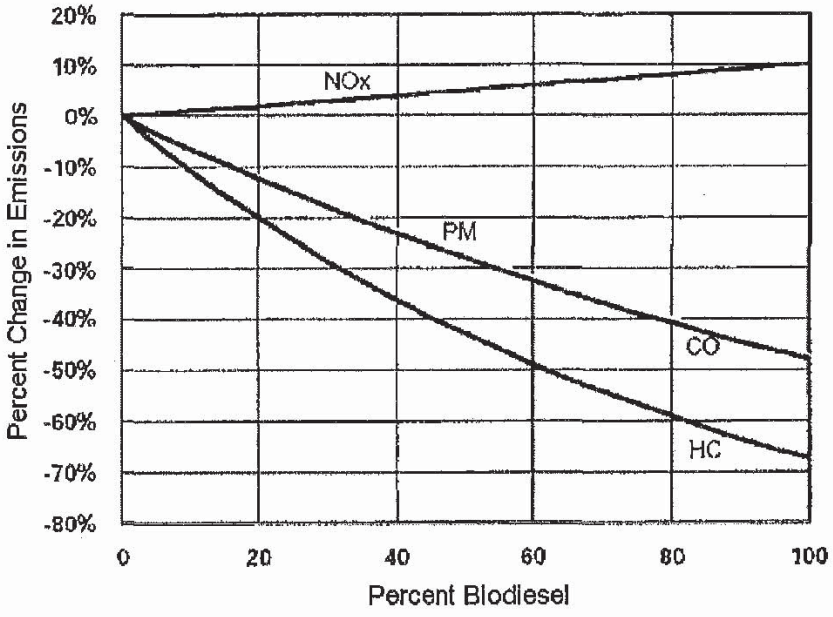
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2.1.4 McCormick 2005

This study tested blends of soy- and animal-based biodiesels with a high-cetane ULSD base fuel at B10 levels and higher. Two engines were tested – a 2002 Cummins ISB and a 2003 DDC Series 60, both with cooled EGR. The hot-start U.S. heavy-duty FTP test cycle was used. The majority of testing was at the B20 level with additional testing at the B50 and B100 levels. One soy-based fuel was tested at B10. The study showed NOx emission increases at B10, B20, and higher levels. The study also investigated mitigation of NOx increases. This study conducted no testing of the NOx emissions impact from biodiesels below the B10 level.

The authors present a figure (reproduced as Figure 2-3) in their introduction that shows their summary of biodiesel emission impacts based on an EPA review of heavy-duty engine testing. It shows NOx emissions increasing linearly with the biodiesel blend percentage.

Figure 2-3
Trend in HC, CO, NOx and PM Emissions with Biodiesel Percent



Source: McCormick 2005

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2.1.5 Nuszkowski 2009

This study tested five different diesel engines: one 1991 DDC Series 60, two 1992 DDC Series 60, one 1999 Cummins ISM, and one 2004 Cummins ISM. Only the 2004 Cummins ISM was equipped with EGR. All testing was done using the hot-start U.S. heavy-duty FTP test cycle. The testing was designed to test emissions from fuels with and without cetane-improving additives. Although a total of five engines were tested, the base diesel and B20 fuels were tested on only two engines (one Cummins and one DDC Series 60) because there was a limited supply of fuel available. NOx emissions increased on the B20 fuel for both engines. A third engine (Cummins) was tested on B20 and B20 blended with cetane improvers to examine mitigation of NOx emissions. This study conducted no testing of the NOx emissions impact from biodiesels at the B10 level or below.

2.1.6 Thompson 2010

This study examined the emissions impacts of soy-based biodiesel at the B10 and B20 levels relative to low-cetane (42), mid-cetane (49), and high-cetane (63) base fuels using one 1992 DDC Series 60 engine. The emissions results were measured on the hot-start U.S. heavy-duty FTP cycle. The study found that NOx emissions were unchanged (observed differences were not statistically significant) at B10 and B20 levels for the low- and mid-cetane fuels. NOx emissions increased significantly at B10 and B20 levels for the high-cetane fuels. This study conducted no testing of the NOx emissions impact from biodiesels at levels below B10.

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2.2 Conclusions Based on Studies Obtained in Literature Search

From the foregoing summary of the studies cited by Staff, we reach the conclusions given below.

1. None of the six studies measured the NOx emissions impact from commercial-grade biodiesel at blending levels below B10, and only two studies tested a fuel at the B10 level. All other testing was at the B20 level or higher. Because none tested a B5 (or similar) fuel, none is capable of providing direct evidence regarding NOx emissions at B5 or other blending levels below B10.

2. These studies provide no data or evidence supporting the validity of Staff's Threshold Model that biodiesel below B10 does not increase NOx emissions. In fact, all of the studies are consistent with the contention that biodiesel increases NOx emissions in proportion to the blending percent.

3. Two of the studies present evidence and arguments that the NOx impact from biodiesel is a continuous effect that is present even at very low blending levels and will increase at higher levels in proportion to the blending percentage. One study tested a Fischer-Tropsch biodiesel blend at B1 and observed NOx emissions to increase (but not by a statistically significant amount).

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3. CARB BIODIESEL CHARACTERIZATION STUDY

3.1 Background

CARB sponsored a comprehensive study of biodiesel and other alternative diesel blends in order "... to better characterize the emissions impacts of renewable fuels under a variety of conditions."[15] The study was designed to test eight different heavy- duty engines or vehicles, including both highway and off-road engines using engine or chassis dynamometer testing. Five different test cycles were used: the Urban Dynamometer Driving Schedule (UDDS), the Federal Test Procedure (FTP), and 40 mph and 50 mph CARB heavy-heavy-duty diesel truck (HHDDT) cruise cycles, and the ISO 8178 (8 mode) cycle. Table 3-1 (reproduced from Table ES-1 of Durbin 2011) documents the scope of the test program. Because the Staff relied only on engine dynamometer testing in its Technology Assessment, only the data for the first four engines (shaded) are considered here.

Table 3-1
A Breakdown of the Test Engines for the Different Categories of Testing

2006 Cummins ISM[a]	Heavy-duty on-highway	Engine dynamometer	
2007 MBE4000	Heavy-duty on-highway	Engine dynamometer	
1998, 2.2 liter, Kubota V2203-DIB	Off-road	Engine dynamometer	
2009 John Deere 4.5 L	Off-road	Engine dynamometer	
2000 Caterpillar C-15	Heavy-duty on-highway	Chassis dynamometer	Freightliner chassis
2006 Cummins ISM	Heavy-duty on-highway	Chassis dynamometer	International chassis
2007 BME4000	Heavy-duty on-highway	Chassis dynamometer	Freightliner chassis
2010 Cummins ISX15	Heavy-duty on-highway	Chassis dynamometer	Kenworth chassis

Source: Table ES-1 of Durbin 2011, page xxvi
Notes:
[a] Data for the first four engines (shaded) are considered in this report.

[15] Durbin 2011, p. xxiv.

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The original goal of this report was to subject all of the NOx emission testing in Durbin 2011 to a fresh re-analysis. However, it was discovered that Durbin 2011 did not report all of the data that were obtained during the program and are discussed in the report. The chassis dynamometer testing was conducted at the CARB Los Angeles facility. Emission results for the chassis dynamometer testing are presented in tabular and graphical form, but the report does not contain the actual emissions test data. For the engine dynamometer testing, some of the measured emission values are not reported even though the emission results are reported in tabulated or graphical form. Requests for the missing data were directed to Durbin in a personal request and to CARB through an official records request. No information has been provided in response and we have not been able to obtain the missing data from online or other sources.

For this report, we have worked with the data in the forms that are provided in Durbin 2011 as being the best-available record of the results of the CARB study. Because Staff used only data obtained in engine dynamometer testing, the analysis presented in this report has done the same. Nevertheless, the results of the chassis dynamometer testing are generally supportive of the results and conclusions presented here. Durbin 2011 notes:

> "... The NOx emissions showed a consistent trend of increasing emissions with increasing biodiesel blend level. These differences were statistically significant or marginally significant for nearly all of the test sequences for the B50 and B100 fuels, and for a subset of the tests on the B20 blends."[16]

Durbin notes that emissions variability was greater in the chassis dynamometer testing, which leads to the sometimes lower levels of statistical significance. There was also a noticeable drift over time in NOx emissions that complicated the results for one engine.

3.2 Data and Methodology

Table 3-2 compiles descriptive information on the engine dynamometer testing performed in Durbin 2011. The experimental matrix involves four engines, two types of biodiesel fuels (soy- and animal-based), and up to four test cycles per engine. However, the matrix is not completely filled with all fuels tested on all engines on all applicable test cycles. The most complete testing is for the ULSD base fuel and B20, B50, and B100 blends. There is less testing for the B5 blend, and B5 is tested using only a subset of cycles. For this reason, we first examine the testing for ULSD, B20, B50, and B100 fuels to determine the overall impact of biodiesels on NOx emissions. We then examine the more limited testing for B5 to determine the extent to which it impacts NOx emissions.

This examination is limited by the form in which emissions test information is reported in Durbin 2011. A complete statistical analysis can be conducted only for the two on-road engines for which Appendices G and H of Durbin 2011 provide measured emissions, and for a portion of the testing of the Kubota off-road engine for which Appendix I provides

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[16] Durbin 2011, p. 126.

Table 3-2 Experimental Matrix for Heavy-Duty Engine Dynamometer Testing Reported in Durbin 2011				
Engine	Biodiesel Type	Fuels Tested	Test Cycles	Notes
On-Road Engines				
2006 Cummins ISM	Soy	ULSD, B20, B50, B100, B5	UDDS, FTP, 40 mph, 50 mph	B5 tested on 40 mph and 50 mph cruise cycles
	Animal	ULSD, B20, B50, B100, B5	UDDS, FTP, 50 mph	B5 tested only on FTP.
2007 MBE4000	Soy	ULSD, B20, B50, B100, B5	UDDS, FTP, 50 mph	B5 tested only on FTP.
	Animal	ULSD, B20, B50, B100, B5		B5 tested only on FTP.
Off-Road Engines				
1998 Kubota V2203-DIB	Soy	ULSD, B20, B50, B100, B5	ISO 8178 (8 Mode)	none
	Animal	Not tested		
2009 John Deere	Soy	ULSD, B20, B50, B100	ISO 8178 (8 Mode)	B5 not tested
	Animal	ULSD, B20, B5		none

measured emissions. The data needed to support a full re-analysis consist of measured emissions on each fuel in gm/hp-hr terms, which are stated in Durbin 2011 as averages across all test replications along with the number of replications and the standard error of the individual tests. With this information, the dependence of NOx emissions on biodiesel blending percent can be determined as accurately as if the individual test values had been reported and the appropriate statistical tests for the significance of results can be performed.

Regression analysis is used as the primary method of analysis. For each engine and test cycle, the emission averages for each fuel are regressed against the biodiesel blending percent to determine a straight line. The regression weights each data point in inverse proportion to the square of its standard error to account for differences in the number and reliability of emission measurements that make up each average. The resulting regression line will pass through the mean value estimated from the data (i.e., the average NOx emission level at the average blending percent), while the emission averages for each fuel may scatter above and below the regression line due to uncertainties in their measurement. The slope of the line estimates the dependence of NOx emissions on the blending percentage.

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Where the data points closely follow a straight line and the slope is determined to be statistically significant, one can conclude that blending biodiesel with a base fuel will increase NOx emissions in proportion to the blending percent. The regression line can then be used to estimate the predicted emissions increase for a given blending percent. The predicted emissions increase is the value one would expect on average over many measurements and is comparable to the average emissions increase one would expect in a fleet of vehicles.

The same level of analysis is not possible for the testing on B5 fuel, which is reported as a simple average for the on-road engines and is not reported at all for the off-road engines. For the B5 fuel, Durbin 2011 presents emission test results in a tabulated form where the percentage change in NOx emissions has been computed compared to ULSD base fuel. This form supports the presentation of results graphically, but it does not permit a proper statistical analysis to be performed. Specifically, the computation of percentage emission changes will perturb the error distribution of the data, by mixing the uncertainty in measured emissions on the base fuel with the uncertainties in measured emissions on each biodiesel blend, and it can introduce bias as a result of the mixing. Further statistical analysis of the computed percent values should be avoided because of these problems. Therefore, a more limited trend analysis of the NOx emissions data for B5 and the John Deere engine is conducted.

3.3 2006 Cummins Engine (Engine Dynamometer Testing)

Table 3-3 shows the NOx emission results for the 2006 model-year Cummins heavy-duty diesel engine based on a re-analysis of the data for this report. As indicated by highlighting in the table, the relationship between increasing biodiesel content and increased NOx emissions for soy-based biodiesel is statistically significant at >95% confidence level[17] in all cases. For the animal-based biodiesel, the relationship is statistically significant at the 92% confidence level for the UDDS cycle, the 94% confidence level for the 50 mph cruise, and the >99% confidence level for the FTP cycle.

For the soy-based fuels, the R^2 statistics show that the emissions effect of biodiesel is almost perfectly linear with increasing biodiesel content over the range B20, B50, and B100. Although not as high for the animal-based fuels (because the emissions effect is smaller and measurement errors are relatively larger in comparison to the trend), the R^2 statistics nevertheless establish a linear increase in NOx emissions with increasing biodiesel content over the same range. The linearity of the response with blending percent is well supported by the many NOx emissions graphs contained in Durbin 2011.

The table also gives the estimated NOx emission increases for B5 and B10 as predicted by the regression lines. For soy-based fuels, the values are 1% for B5 (range 0.8% to 1.3% depending on the cycle) and 2% for B10 (range 1.6% to 2.6% depending on cycle).

[17] A result is said to be statistically significant at the 95% confidence level when the p value is reported as $p \leq 0.05$. At the $p \leq 0.01$ level, a result is said to be statistically significant at the 99% confidence level, and so forth.

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Table 3-3 Re-Analysis for 2006 Cummins Engine (Engine Dynamometer Testing) Model: NOx = A + B · BioPct Using ULSD, B20, B50, and B100 fuels							
Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	Pct Change	Pct Change
Soy-based							
	UDDS	0.997	5.896	0.0100 [a]	0.001	0.8%	1.7%
	FTP	0.995	2.024	0.0052	0.003	1.3%	2.6%
	40 mph	1.000	2.030	0.0037	<0.0001	0.9%	1.8%
	50 mph	0.969	1.733	0.0028	0.016	0.8%	1.6%
Animal-based							
	UDDS	0.847	5.911	0.0021 [b]	0.080	0.2%	0.4%
	FTP	0.981	2.067	0.0031	0.001	0.7%	1.4%
	50 mph	0.887	1.768	0.0011	0.058	0.3%	0.6%

Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better.
[b] Orange highlight indicates result is statistically significant at the 90% confidence level or better.

For animal-based fuels, the values are approximately one-half as large: 0.4% for B5 (range 0.2% to 0.7%) and 0.8% for B10 (range 0.4% to 1.4%). These predicted increases are statistically significant to the same degree as the slope of the regression line from which they are estimated. That is, the NOx increases predicted by the regression line for soy-based fuels are statistically significant at the 95% confidence level (or better) on all cycles and the predicted NOx increases for animal-based fuels are statistically significant at the 90% confidence level (or better) on all cycles and at the >99% confidence level for the FTP.

Because the limited data on B5 were not used to develop the regression lines for each cycle, and no test data on B10 are available, use of the lines to make predictions for B5 and B10 depends on their linearity over the range between ULSD and B20. Based on the R^2 statistics and the graphs in Durbin 2011, the slopes observed between ULSD and B20 are the same as the slopes observed between B20 and B100 for each of the test cycles. We believe that the linearity of the response with blending percent for values over the range ULSD to B100 would be accepted by the large majority of researchers in the field, as would the use of regression analysis to make predictions for B5 and B10.

The Durbin 2011 report takes a different approach for determining the statistical significance of NOx emission increases for each fuel. For each fuel tested, it computes a percentage change in emissions for NOx (and other pollutants) relative to the ULSD base fuel. It then determines the statistical significance of each observed change using a conventional t-test for the difference of two mean values (2-tailed, 2 sample equal

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variance t-test). The t-test is conducted on the measured emission values before the percentage emission change is computed.

The t-test would be the appropriate approach for determining statistical significance if only two fuels were tested. However, it is a simplistic approach when three or more fuels are tested because it is applied on a pair-wise basis (B5 vs. ULSD, B20 vs. ULSD, etc.) and does not make use of all of the data that is available. It will have less power than the regression approach to detect emission changes that are real. This limitation is in one direction, however, in that the test is too weak when 3 or more data points are available, but a finding of statistical significance is valid when it occurs. As long as the linear hypothesis is valid, the regression approach should be the preferred method for analysis and for the determination of whether biodiesel blending significantly increases NOx emissions.

Because emission changes will be smallest for B5 (because of the low blending volume), the pair-wise t-test is most likely to fail to find statistical significance at the B5 level. In cases where the pair-wise t-test for B5 says that the emission change vs. ULSD is not statistically significant – but slope of the regression line is statistically significant – the proper conclusion is that additional B5 testing (to improve the precision of the emission averages) would likely lead to the detection of a statistically significant B5 emissions change using the t-test. In this case, the failure to find statistical significance using the t-test is not evidence that B5 does not increase NOx emissions.

For this engine, soy-based B5 was tested on the 40 mph and 50 mph cruise cycles and animal-based B5 was tested on the FTP. To examine this matter further, Table 3-4 reproduces NOx emission results reported in Tables ES-2 and ES-3 of Durbin 2011. Soy-based B5 was shown to increase NOx emissions on the 40 mph cruise cycle, but not on the 50 mph cruise cycle. Animal-based B5 was shown to increase NOx emissions on the FTP. Durbin 2011 noted (p. xxxii) that "[t]he 50 mph cruise results were obscured, however, by changes in the engine operation and control strategy that occurred over a segment of this cycle." Therefore, we discount the 50 mph cruise results and do not consider them further. Neither of the remaining B5 NOx emission increases (for the 40 mph Cruise and FTP cycles) were found to be statistically significant using the t-test, although the 40 mph cruise result for soy-based fuels comes close to being marginally significant (it would be statistically significant at an 86.5% level). The NOx emission increases at higher blending levels were found have high statistical significance (>99% confidence level).

This format, used throughout Durbin 2011 to report emission test data and to show the effect of biodiesel on emissions, is subject to an important statistical caveat. The percent changes are computed by dividing the biodiesel emission values by the emissions measured for the ULSD base fuel. Therefore, measurement errors in the ULSD measurement are blended with the measurement errors for each of the biodiesel fuels. The blending of errors in each computed percent change can bias the apparent trend of emissions with increasing biodiesel content. As will be shown in Section 3.3.2, we can see this problem in the animal-based B5 test data for this engine.

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Table 3-4 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 2006 Cummins Engine (Engine Dynamometer Testing)						
	Soy-based Biodiesel				Animal-based Biodiesel	
	40 mph Cruise		50 mph Cruise		FTP	
	NOx % Diff	p value	NOx % Diff	p value	NOx % Diff	p value
B5	1.7%	0.135	-1.1%	0.588	0.3%	0.298
B20	3.9%[a]	0.000	0.5%	0.800	1.5%	0.000
B50	9.1%	0.000	6.3%	0.001	6.4%	0.000
B100	20.9%	0.000	18.3%	0.000	14.1%	0.000

Source: Table ES-2 and ES-3 of Durbin 2011, p. xxviii
Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on the pair-wise t-test.

3.3.1 NOx Impact of Soy-based Biodiesel at the B5 Level

Figures 3-1a and 3-1b display the trend of NOx emissions with blending percent for the soy-based biodiesel on the 40 mph cruise cycle. Figure 3-1a plots the percentage increases as reported by Durbin 2011 in contrast to two different analytical models for the relationship:

- The Linear Model shown by the blue line; and
- The Staff Threshold model (black line), in which the NOx emission change is zero through B9 and then increases abruptly to join the linear model.

In Figure 3-1a, the linear model is an Excel trendline for the computed percent changes. While the data violate a key assumption for the proper use of regression analysis, this approach is the only way to establish a trendline given the form in which Durbin 2011 tabulates the data and presents the results of its testing.

Figure 3-1b plots the actual measured emission values in g/bhp-hr terms in contrast to the same two analytical models. Here, the linear model line is determined through a proper use of regression analysis, in which each emission average in g/bhp-hr terms is weighted inversely by the square of its standard error, using the data for ULSD, B20, B50 and B100 (i.e., excluding the B5 data point). In the case of this engine and biodiesel fuel, both forms of assessment show generally the same trend for NOx emissions as a function of blending percent. Although the NOx emission increases for B5 may fail the t-test for significance, emissions are increased at B5 and the B5 data point is fully consistent with the Linear Model. The Threshold model is clearly a less-satisfactory representation of the test data.

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Figure 3-1a
Durbin 2011 Assessment: 40 mph Cruise Cycle NOx Emissions Increases for Soy-Biodiesel Blends (2006 Cummins Engine)

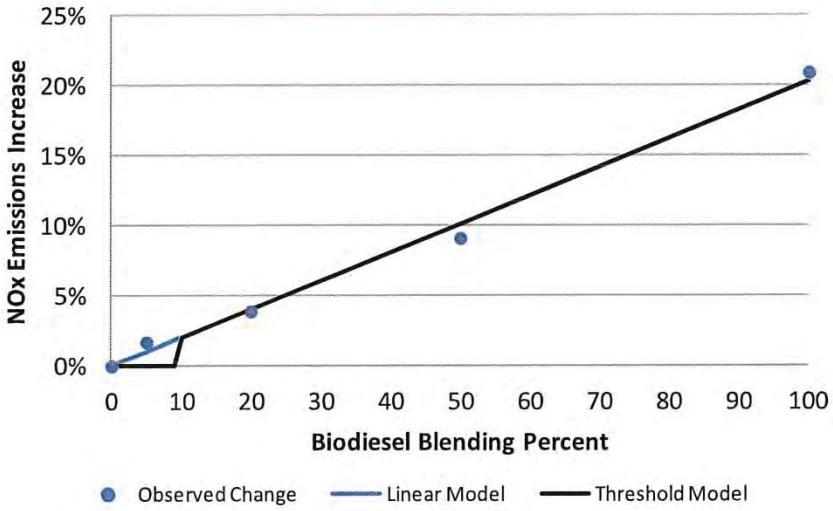
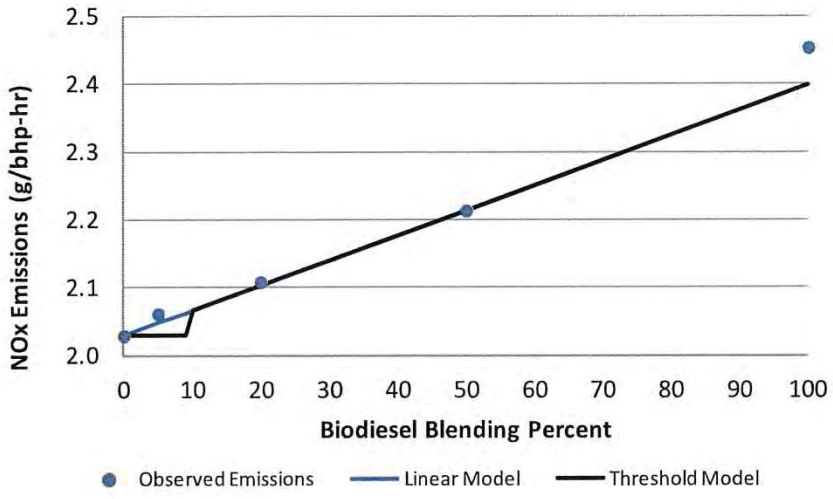


Figure 3-1b
Re-assessment of 40 mph Cruise Cycle NOx Emissions Increases for Soy-Biodiesel Blends (2006 Cummins Engine)



Note that the slope of the trendline (Figure 3-1a) is greater than the slope of the regression line (Figure 3-1b). In the latter figure, the B100 data point stands above the regression line, which passes below it. The regression line (but not the trendline) is fit in

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a manner that accounts for the uncertainties in each data point, so that the line will pass closer to points that have smaller uncertainties and farther from points that have greater uncertainties. For these data, the B100 data point has the largest uncertainty (±0.026 g/bhp-hr) followed by the B20 data point (±0.025 g/bhp-hr). The other three data points (ULSD, B5, and B50) have uncertainties less than ±0.001 g/bhp-hr. The B20 data point happens to fall on the line, but the B100 data point is found to diverge above. Because the regression analysis can account for the relative uncertainties of the data points, it provides a more accurate and reliable assessment of the impact on NOx emissions.

3.3.2 NOx Impact of Animal-based Biodiesel at the B5 level

Figures 3-2a and 3-2b display the trend of NOx emissions with blending percent for the animal-based biodiesel on the FTP test cycle as reported by Durbin 2011 and as re-assessed in this report using regression analysis, respectively. As Figure 3-2a shows, the NOx percent change values reported by Durbin 2011 appear to follow the Staff Threshold model in that NOx emissions are not materially increased at B5, but are increased significantly at B20 and above. As a result, the blue trendline in the figure (fit from the B20, B50 and B100 data points) has a negative intercept.

Figure 3-2b paints a very different picture from the data. Here, the ULSD and B5 data points stand above the weighted regression line (blue) developed from the data for ULSD, B20, B50 and B100. In the data used to fit the regression line, the ULSD data point has the largest uncertainty (±0.013 g/bhp-hr) while the other three data points (B20, B50, and B100) have uncertainties of ±0.002 g/bhp-hr (one case) and ±0.001 g/bhp-hr (two cases). Considering all of the data, the B5 data point has the second highest uncertainty (±0.007 g/bhp-hr). The regression line closely follows a linear model with a high R^2 (0.981) considering the weighted errors, while the ULSD and B5 points lie above it.

Because the ULSD data point is subject to more uncertainty and appears to be biased high compared to the regression line, the NOx percent changes computed by Durbin 2011 are themselves biased. The trendline result in Figure 3-2a that appeared to be supportive of the Staff Threshold model now appears to be the result of biases in the ULSD and B5 emission averages.

Two important conclusions can be drawn from the foregoing:

1. Accurate and reliable conclusions regarding the impact of B5 on NOx emissions cannot be drawn from the computed percent changes that are reported in Durbin 2011. Nor can accurate and reliable conclusions be drawn from visual inspection of graphs that present such data. Weighted regression analysis of the measured emission values (g/bhp-hr terms) must be performed so that the uncertainties in emissions measurements can be fully accounted for.

2. When a weighted regression analysis is performed using the testing for this engine, there is no evidence that supports the conclusion that B5 blends will not increase NOx emissions. In fact, the data are consistent with the conclusion that biodiesel increases NOx emissions in proportion to the blending percent.

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Figure 3-2a
Durbin 2011 Assessment: FTP NOx Emissions Increases for Animal-based Biodiesel Blends (2006 Cummins Engine)

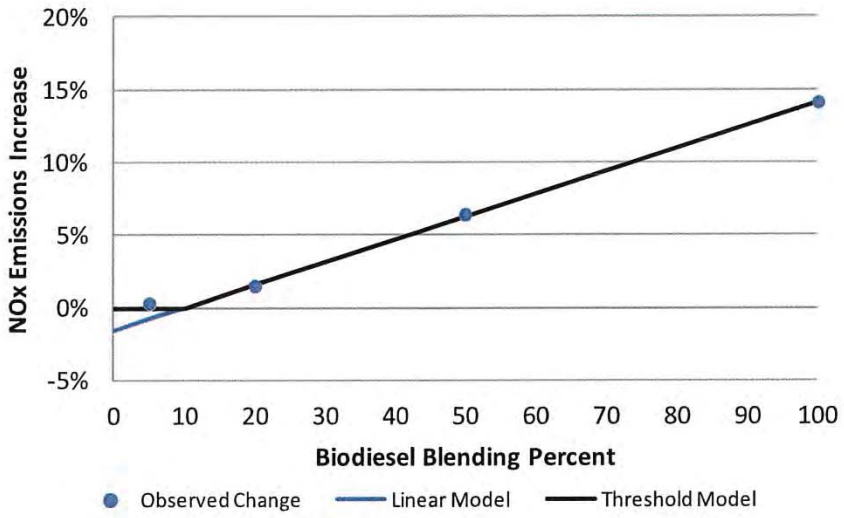
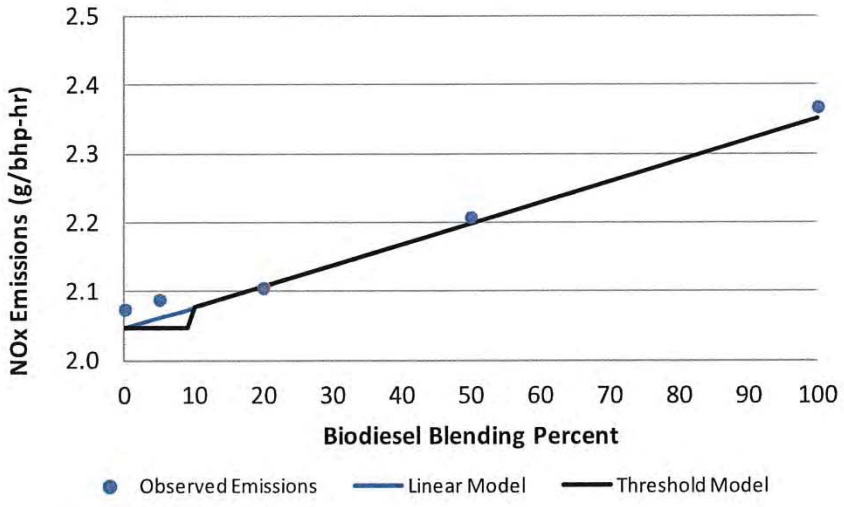


Figure 3-2b
Re-assessment of FTP NOx Emissions Increases for Animal-based Biodiesel Blends (2006 Cummins Engine)



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3.4 2007 MBE4000 Engine (Engine Dynamometer Testing)

To analyze the data for the 2007 MBE4000 engine, it has proved necessary to remove two data points, one for the soy-based B20 fuel on the 50 mpg cruise cycle and one for the animal-based B50 fuel on the FTP test cycle:

- Appendix H reports the 50 mph cruise emission average for soy-based B20 to be 0.014 ± 0.020 g/bhp-hr. This value is implausible and wholly inconsistent with the NOx emission change of +6.9% reported in Table ES-4 of Durbin 2011, which would imply a NOx emission average of 1.21*1.069 = 1.30 g/bhp-hr.

- Appendix H reports the FTP emission average for the animal-based B50 fuel to be 2.592 ± 0.028 g/bhp-hr, which stands well above the other test data on animal-based biodiesel. This value is also inconsistent with the NOx emission change of +12.1% reported in Table ES-4 of Durbin 2011, which would imply a NOx emission average of 1.29*1.121 = 1.45 g/bhp-hr.

We believe these reported values are affected by typographical errors and have deleted them from the dataset used here.

With these corrections, Table 3-5 shows the results of the NOx emissions analysis for the 2007 model-year MBE4000 heavy-duty diesel engine. As indicated by highlighting in the table, the relationship between increasing biodiesel content and increased NOx emissions is statistically significant at >99% confidence level in two cases for soy-based biodiesel (the UDDS and FTP cycles) and at the 90% confidence level in one case (the 50 mph cycle). For the animal-based biodiesel, the relationship is statistically significant at the 96% confidence level for the UDDS cycle, the 98% confidence level for the FTP cycle, and >99% confidence level for the 50 mph cycle.

Durbin 2011 again notes a problem with the 50 mph cruise test results, saying (p. xxxii) that "[the NOx] trend was obscured, however, by the differences in engine operation that were observed for the 50 mph cruise cycle." Therefore, we will focus the discussion on the UDDS and FTP results.

For the soy-based fuels, the R^2 statistics show that the emissions effect of biodiesel is almost perfectly linear with increasing biodiesel content over the range from ULSD to B20, B50, and B100 for all cycles (including the 50 mph cruise). That is, the NOx emissions increase between ULSD and B20 shares the same slope as the NOx emissions increase between B20 and B100. For the animal-based biodiesel, the R^2 statistics also establish a linear increase in NOx emissions with increasing biodiesel content over the same range. The linearity of the response with blending percent is also well supported by the many NOx emissions graphs contained in Durbin 2011.

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Tab le 3-5 Re-Analysis for 2007 MBE4000 En gine (En gine Dynam ometer Testing) Model: NOx = A + B · BioPct Using ULSD, B20, B50, and B100 fuels							
Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	Pct Change	Pct Change
Soy-based							
	UDDS	0.989	2.319	0.0090 [a]	0.005	4.6%	9.1%
	FTP	0.998	1.268	0.0049	0.006	2.5%	5.0%
	50 mph	0.979	1.198	0.0054 [b]	0.092	2.7%	5.5%
Animal-based							
	UDDS	0.913	2.441	0.0036	0.044	2.0%	4.0%
	FTP	0.999	1.288	0.0038	0.020	2.5%	5.0%
	50 mph	0.994	1.205	0.0049	0.003	2.5%	5.0%

Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better.
[b] Orange highlight indicates result is statistically significant at the 90% confidence level or better.

The table also gives the estimated NOx emission increases for B5 and B10 as predicted by the regression lines. For soy-based fuels, the values are ~3.5% for B5 (range 2.5% to 4.6% depending on the cycle) and ~7.5% for B10 (range 5.0% to 9.1% depending on cycle). For animal-based fuels, the values are approximately two-thirds as large: ~2.3% for B5 (range 2.0% to 2.5%) and ~4.5% for B10 (range 4.0% to 5.0%). The predicted increases are statistically significant to the same degree as the slope of the regression line from which they are estimated. That is, the predicted NOx increases are statistically significant at the >99% confidence level for soy-based fuels on the UDDS and FTP cycles and at the >95% confidence level for animal-based fuels on all cycles. The predicted NOx increase is statistically significant at the 90% confidence level for soy-based fuels on the 50 mph cruise cycle.

For this engine, soy- and animal-based B5 were tested on the FTP. Table 3-6 reproduces the NOx emission results reported in Tables ES-4 and ES-5 of Durbin 2011. While there are caveats on use of the pair-wise t-test, the FTP test data for this engine show NOx emissions at the B5 level for both soy- and animal-based fuels that are statistically significant at the 99% confidence level (or better) in this case. That is, the test data for this engine as reported by Durbin 2011 refute the Staff Threshold Model that biodiesel blends below B10 do not increase NOx emissions.

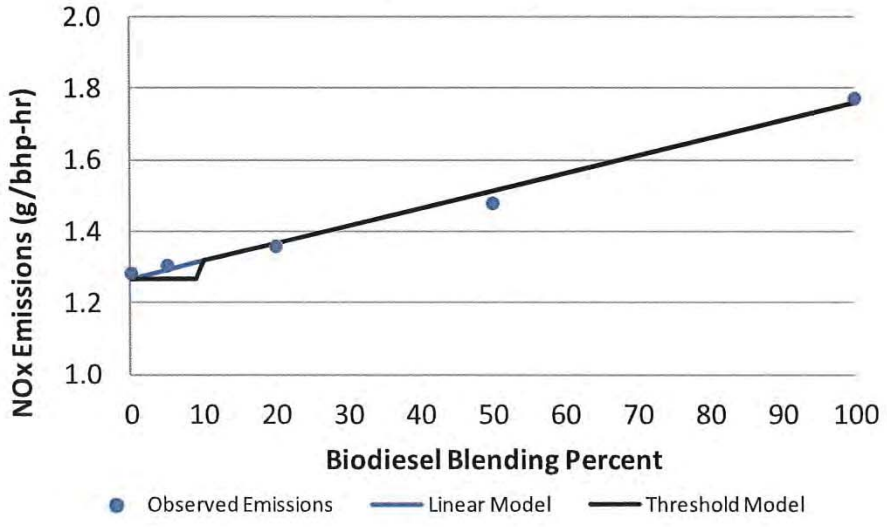
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Table 3-6 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 2007 MBE4000 Engine (Engine Dynamometer Testing)				
	Soy-Based Biodiesel FTP		Animal-Based Biodiesel FTP	
	NOx % Diff	p value	NOx % Diff	p value
B5	0.9% [a]	0.007	1.3%	0.000
B20	5.9%	0.000	5%	0.000
B50	15.3%	0.000	12.1	0.000
B100	38.1%	0.000	29%	0.000

Source: Table ES-4/5 of Durbin 2011, p. xxix
Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on pair-wise t-test.

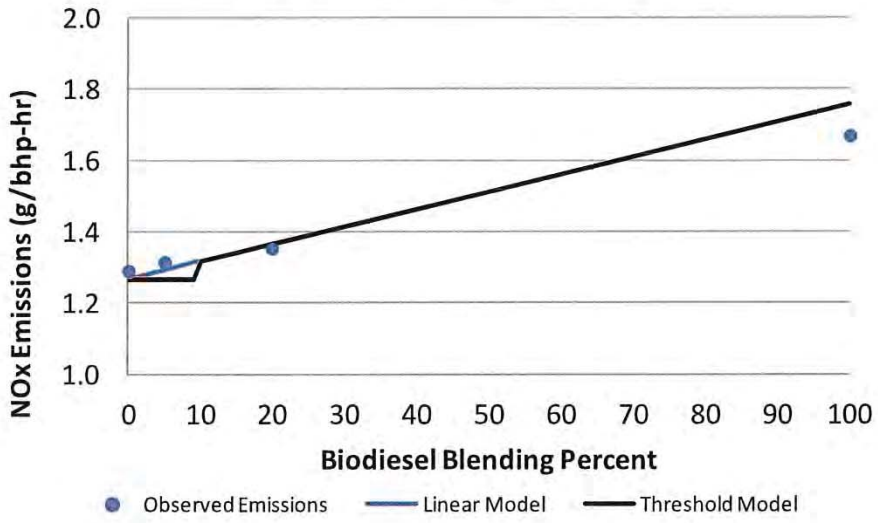
Figures 3-3a and 3-3b below compare the FTP data for this engine to the regression line representing the linear model (blue) and the Staff Threshold model (black) for both soy- and animal-based biodiesel. In both cases, the regression line was developed using the data for ULSD, B20, B50, and B100 (i.e., excluding the B5 data point). For both soy- and animal-based biodiesels, the data point for B5 falls on the established line, while the Staff Threshold model is inconsistent with the data. For this engine, it is clear that soy- and animal-based biodiesels increase NOx emissions at all blending levels.

Figure 3-3a
Re-assessment of FTP Cycle NOx Emissions Increases for Soy-based Biodiesel Blends (2007 MBE4000 Engine)



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Figure 3-3b
Re-assessment of FTP Cycle NOx Emissions Increases for Animal-based Biodiesel Blends (2007 MBE4000 Engine)



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3.5 1998 Kubota TRU Engine (Engine Dynamometer Testing)

The 1998 Kubota V2203-DIB off-road engine was tested on the base fuel (ULSD) and soy-based biodiesel at four blending levels (B5, B20, B50, B100) in two different series using the ISO 8178 (8-mode) test cycle. Appendix I reports the measured emissions data only for the first series (ULSD, B50, B100). Using this subset of data, Table 3-7 summarizes the results of the re-analysis for this engine.

As for the other engines, the results of the analysis demonstrate the following:

- The high R^2 statistic shows that the emissions effect of biodiesel is almost perfectly linear over the range B50 and B100. That is, the slope from ULSD to B50 is the same as the slope from B50 to B100. The slope of the regression line is statistically significant at the 99% confidence level.

- NOx emissions are estimated to increase by 1.0% at the B5 level and by 2.1% at the B10 level. These estimated NOx emission increases are statistically significant to the same high degree as the regression slope on which they are based.

Table 3-7 Re-Analysis for 1998 Kubota V2203-DIB Engine (Engine Dynamometer Testing) Model: NOx = A + B · BioPct Using ULSD, B50, and B100 fuels							
Biodiesel Type	Test Cycle	R^2	Intercept A	BioPct Slope B		Predicted NOx Increase for B5	Predicted NOx Increase for B10
			Value	Value	p value	Pct Change	Pct Change
Soy-based	ISO 8178	0.999	12.19	0.0256 [a]	0.01	1.0%	2.1%

Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better.

The second test series involved ULSD, B5, B20, and B100 fuels. Measured emissions data are not given in Appendix I, so we must work with the calculated percent changes in NOx emissions tabulated in Durbin 2011. Table 3-8 reproduces the NOx emission results reported in Table ES-8 of Durbin 2011 for the two test series. For the second test series, biodiesel at the B5 level increased NOx emissions, but the result fails the pair-wise t-test for statistical significance. The NOx emission increase at the B20 level was statistically significant at the 90% confidence level, and the increase at the B100 level was statistically significant at the >99% confidence level. The significance determinations use the pair-wise t-test, which is subject to caveats, but this is the only method available to gauge significance because re-analysis of the computed percentage changes is not possible.

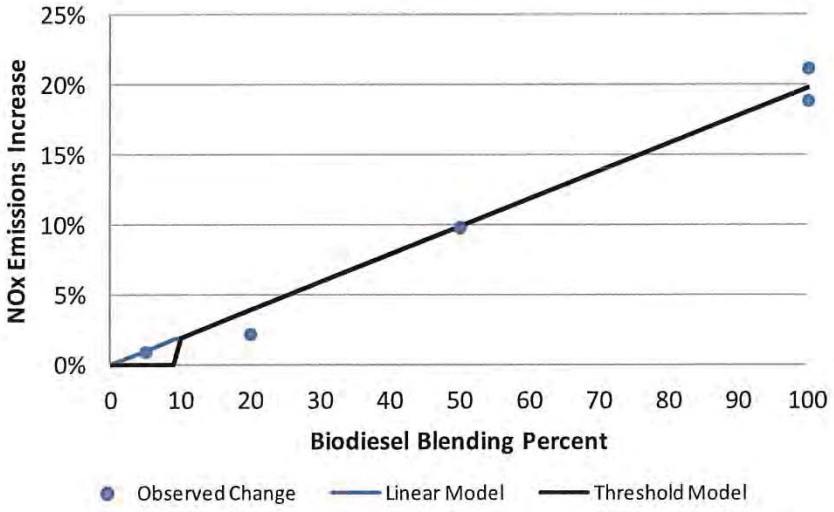
Table 3-8 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 1998 Kubota TRU Engine (Engine Dynamometer Testing)				
	Soy-Based Biodiesel Series 1 ISO 8178		Soy-Based Biodiesel Series 2 ISO 8178	
	NOx % Diff	p value	NOx % Diff	p value
B5	Not tested		0.97%	0.412
B20	Not tested		2.25% [a]	0.086
B50	7.63% [b]	0.000	Not tested	
B100	13.76%	0.000	18.89%	0.000

Source: Table ES-8 of Durbin 2011, p. xxxviii
Notes:
[a] Orange highlight indicates result is statistically significant at the 90% confidence level or better based on pair-wise t-test.
[b] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on pair-wise t-test

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Figure 3-4 displays the trend of NOx emissions with blending percent for the first and second test series combined. As the figure shows, the available data points scatter around the trendline determined from the emission change percentages (not from regression analysis). The B20 data point falls below the trend line while the two B100 data points bracket the trend line. It is not possible to explain the divergence of the B20 data point

Figure 3-4
Durbin 2011 Assessment: ISO 8178 Cycle NOx Emissions Increases for Soy-based Biodiesel Blends (1998 Kubota Engine, Test Series 1 and 2 Combined)



because the emissions data for the second test series are not published in Durbin 2011. The B5 data point clearly supports the Linear Model and is inconsistent with the Staff Threshold Model.

3.6 2009 John Deere Off-Road Engine (Engine Dynamometer Testing)

The only information on the 2009 John Deere off-road engine comes from the tabulation of calculated percentage emission changes. Table 3-9 reproduces these data from Table ES-7 of Durbin 2011. For the soy-based biodiesel, NOx emissions are significantly increased at the B20 and higher blend levels. The increase for B20 is statistically significant at the 90% confidence level and the increases for B50 and B100 are statistically significant at the >99% confidence level based on the pair-wise t-test. A soy-based B5 fuel was not tested.

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Table 3-9 Percentage Change in NOx Emissions for Biodiesel Blends Relative to ULSD: 2009 John Deere Engine (Engine Dynamometer Testing)				
	Soy-Based Biodiesel ISO 8178		Animal-Based Biodiesel ISO 8178	
	NOx % Diff	p value	NOx % Diff	p value
B5	Not tested		-3.82	0.318
B20	2.82%[a]	0.021	-2.20	0.528
B50	7.63%	0.000	Not tested	
B100	13.76%	0.000	4.57	0.000

Source: Table ES-7 of Durbin 2011, p. xxxviii
Notes:
[a] Blue highlight indicates result is statistically significant at the 95% confidence level or better based on pair-wise t-test.

For animal-based biodiesel, the testing shows the unusual result that B5 and B20 appear to decrease NOx emissions, while B100 increases NOx. The B5 and B20 decreases are not statistically significant, while the B100 increase is statistically significant at the >99% confidence level. Durbin 2011 concludes:

> The animal-based biodiesel also did not show as great a tendency to increase NOx emissions compared to the soy-based biodiesel for the John Deere engine, with only the B100 animal-based biodiesel showing statistically significant increases in NOx emissions.[18]

Durbin 2011 does not discuss these results further and does not note any problems in the testing, making further interpretation of the results difficult. Figure 8-1 of Durbin 2011 presents the NOx results for this engine with error bars. First, we note that the figure appears to suggest that NOx emissions were increased on the B20 fuel in contradiction to the table above. Second, it is clear that the error bars are large enough that no difference in NOx emissions can be detected among ULSD, B5, and B20 fuels. Overall, this result could be consistent with the Staff Threshold Model through B5, but the failure to detect a NOx emission increase at B20 is not. Without further information, it is not possible to determine whether the result seen here is a unique response of the John Deere engine to animal-based biodiesel or is the result of a statistical fluctuation or an artifact in the emissions data.

3.7 Conclusions

The Biodiesel Characterization report prepared by Durbin et al. for CARB is an important source of information on the NOx emissions impact of biodiesel fuels in heavy-duty engines. It is the sole source of information on the NOx impact of B5 blends cited in the ISOR. When the engine dynamometer test data are examined for

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[18] Durbin 2011, p. xx.

the three engines for which emissions test data have been published, we find clear evidence that biodiesel increases NOx emissions in proportion to the blending percent. Where B5 fuels were tested for these engines, NOx emissions are found to increase above ULSD for both soy- and animal-based blends in all three engines and by statistically significant amounts in one engine.

Specifically, a re-analysis of the NOx emissions test data demonstrates the following:

1. For the 2006 Cummins engine, biodiesel fuels are found to significantly increase NOx emissions for both soy- and animal-based blends by amounts that are proportional to the blending percent. This result indicates that biodiesels will increase NOx emissions at blending levels below B10. When B5 fuels were tested, NOx emissions were observed to increase but by amounts that fail to reach statistical significance according to the pair-wise test.[19] Graphical analysis demonstrates that NOx emissions measured for B5 fuels are consistent with the Linear Model, but not the Staff Threshold Model.

2. For the 2007 MBD4000 engine, biodiesel fuels are found to significantly increase NOx emissions for both soy- and animal-based blends by amounts that are proportional to the blending percent. This result indicates that biodiesels will increase NOx emissions at blending levels below B10. When B5 fuels were tested, NOx emissions were observed to increase and by amounts that are found to be statistically significant using the pair-wise t-test.[13] This result alone is sufficient to disprove the Staff Threshold Model. Graphical analysis demonstrates that NOx emissions measured for B5 fuels are consistent with the Linear Model, but not the Staff Threshold Model.

3. For the 1998 Kubota TRU (off-road) engine, soy-based biodiesel fuels are found to significantly increase NOx missions. Animal-based biodiesel was not tested. When a soy-based B5 fuel was tested, NOx emissions were observed to increase but by amounts that fail to reach statistical significance according to the pair-wise test.[13] Graphical analysis demonstrates that NOx emissions measured for B5 fuels are consistent with the Linear Model, but not the Staff Threshold Model.

The measured emissions test data for the other off-road engine (2009 John Deere) are not contained in the Durbin 2011 report and CARB has not made them publicly available. Thus, a re-analysis was not possible. Based on the tables and figures in Durbin 2011, soy-based biodiesel fuels were shown to significantly increase NOx emissions at B20 levels and higher, but B5 was not tested. Testing of animal-based blends shows no change in NOx emissions at B5 and B20 levels, but B100 is shown to significantly increase NOx emissions. Durbin 2011 discusses this result only briefly, and it is unclear what conclusions can be drawn from it.

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[19] As discussed in Section 3.3, the pair-wise t-test is not the preferred method for demonstrating statistical significance.

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3_B_ADF_GE Responses (Page 405 – 442)

234. Comment: **NOx Emissions Impact of Soy- and Animal-based Biodiesel Fuels: A Re- Analysis December 10, 2013**

Agency Response:
This is the third time this document was submitted by Growth Energy. It is a reproduction of comments **ADF B3-46** through **ADF B3-92**. The responses to these comments are in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

APPENDIX A

RESUME OF ROBERT W. CRAWFORD

Education

1978 Doctoral Candidate, ScM. Physics, Brown University, Providence, Rhode Island
1976 B.A. Physics, Pomona College, Claremont, California

Professional Experience

1998-Present Independent Consultant

Individual consulting practice emphasizing the statistical analysis of environment and energy data with an emphasis on how data and statistics are properly used to make scientific inferences. Mr. Crawford provides support on statistical, data analysis, and modeling problems related to ambient air quality data and emissions from mobile and stationary sources.

Ambient Air Quality and Mobile Source Emissions – Mr. Crawford has worked with Sierra Research on elevated ambient CO and PM concentrations in Fairbanks AK and Phoenix AZ, including the effect of meteorological conditions on ambient concentrations, the relationship of concentrations to source inventories, and the use of non-parametric techniques to infer source location from wind speed and direction data. Ongoing work is employing Principal Components Analysis to elucidate the relationship between meteorology and $PM_{2.5}$ concentrations in Fairbanks. In the past year, this work led to creation of the AQ Alert System, a tool used by air quality staff to track $PM_{2.5}$ monitor concentrations during the day and to prepare AQ alerts over the next 3 days based on the meteorological forecast.

In past work for Sierra, he has also conducted studies of fuel effects on motor vehicle emissions for Sierra. For CRC, he determined the relationship between gasoline volatility and oxygen content on tailpipe emissions of late model vehicles at FTP and cold-ambient temperatures. For SEMPRA, he determined the relationship between CNG formulation and tailpipe emissions of criteria pollutants and a range of air toxics. Other work has included the design of vehicle surveillance surveys and determination of sample sizes, development of screening techniques similar to discriminant functions to improve the efficiency of vehicle recruitment, the analysis of vehicle failure rates measured in inspection & maintenance programs, and the statistical evaluation of data collected on freeway speeds using automated sensors.

Stationary Source Emissions – Over the past 5 years, Mr. Crawford has worked with AEMS, LLC on EPA's MACT and CISWI rulemakings for Portland Cement plants, in which significant issues related to data quality, data reliability, and emissions variability are evident. Key issues include the need to properly account for uncertainty and emissions variability in setting emission standards. He also supported AEMS in the

current EPA rulemaking on reporting of greenhouse gas emissions from semiconductor facilities, where the proper characterization of emission control device performance was a key issue. He is currently supporting AEMS in a regulatory process to re-determine emission standards for an industrial facility where the new standard will be enforced by continuous emissions monitoring (CEMS). At issue is how to set the standard in such a way that there will be no more than a small, defined risk that 30-day emission averages will exceed the limitations while emissions remain well-controlled .

Advanced Combustion Research – In recent work for Oak Ridge National Laboratory, Mr. Crawford conducted a series of statistical studies on the fuel consumption and emissions performance of Homogenous Charge Compression Ignition (HCCI) engines. One of these studies was for CRC, in which fuel chemistry impacts were examined in gasoline HCCI. In HCCI, the fuel is atomized and fully-mixed with the intake air charge outside the cylinder, inducted during the intake stroke, and then compressed to the point of spontaneous combustion. The timing of combustion is controlled by heating of the intake air. If R&D work can demonstrate a sufficient understanding of how fuel properties influence engine performance, the HCCI combustion strategy potentially offers the fuel economy benefit of a diesel engine with inherently lower emissions.

1979-1997 Energy and Environmental Analysis, Inc., Arlington, VA. Director & Partner (from 1989).

Primary work areas: Studies of U.S. energy industries for private and institutional clients emphasizing statistical analysis, business planning and computer modeling/forecasting. Responsible for the EEA practice area that provided strategic planning and forecasting services to major energy companies. Primary topical areas included: U.S. energy market analysis and strategic planning; gas utility operations; and natural gas supply planning.

U.S. Energy Market Analysis

During 1995-1997, Mr. Crawford directed EEA's program to provide comprehensive energy supply and demand forecasting for the Gas Research Institute (GRI) in its annual Baseline Projection of U.S. Energy Supply and Demand. Services included: development of U.S. energy supply, demand, and price forecasts; sector-specific analyses covering energy end-use (residential, commercial, industrial, transportation), electricity supply, and natural gas supply and transportation; and the preparation of a range of publications on the forecasts and energy sector trends.

From 1989 through 1997, he directed the use of EEA's Energy Overview Model in strategic planning and long-term market analysis for a client base of major energy producers, pipelines, and distributors in both the United States and Canada. The Energy Overview Model was used under his direction as the primary analytical basis for the 1992 National Petroleum Council study The Potential for Natural Gas in the United States. Mr. Crawford also provided analysis for clients on a wide range of other energy market issues, including negotiations related to an LNG import project intended to serve U.S. East Coast markets. This work assessed the utilization and economic value of seasonal

gas deliverability in order to develop LNG pricing formulas and evaluate the project's viability.

Other topical areas of work during his period of employment with EEA include:

Gas Load Analysis and Utility Operations – Principal investigator in a multi-year research program for the Gas Research Institute (GRI) that examined seasonal gas loads, utility operations, and the implications for transmission and storage system reliability and capacity planning.

Gas Transmission and Storage – Principal investigator for a study of industry plans for expansion of underground gas storage capacity in the post-Order 636 environment, including additions of depleted-reservoir and salt-formation storage, an engineering analysis of capital and operating costs for the projects, and unbundled rates for new storage services.

Natural Gas Supply Planning – Mr. Crawford was EEA's senior manager and lead analyst on gas supply planning issues for both pipeline and distribution companies, which included technical and analytic support in development and justification of gas supply strategies; and identification of optimal seasonal supply portfolios for Integrated Resource Planning proceedings.

Transportation Systems Research

Mr. Crawford also had extensive experience in motor vehicle fuel economy and emissions while at EEA. He participated for five years in a DOE research program on fuel economy, with emphasis on the evaluation of differences between laboratory and on-road fuel economy. His work included analysis of vehicle use databases to understand how driving patterns and ambient (environmental) conditions influence actual on-road fuel economy. He also developed a software system to link vehicle certification data systems to vehicle inspection and testing programs and participated in a range of studies on vehicle technology, fuel economy, and emissions for DOE, EPA, and other governmental agencies.

SELECTED PUBLICATIONS (emissions and motor vehicle-related topics)

Statistical Assessment of $PM_{2.5}$ and Meteorology in Fairbanks, Alaska: 2013 Update. Crawford and Dulla. Prepared for the Alaska Department of Environmental Conservation. (forthcoming).

Statistical Assessment of $PM_{2.5}$ and Meteorology in Fairbanks, Alaska. Crawford and Dulla. Prepared for the Alaska Department of Environmental Conservation. March 2012.

Principal Component Analysis: Inventory Insights and Speciated $PM_{2.5}$ Estimates. Crawford. Presentation at Air Quality Symposium 2011, Fairbanks and North Star Borough, Fairbanks, AK. January 2011.

Influence of Meteorology on $PM_{2.5}$ Concentrations in Fairbanks Alaska: Winter 2008-2009. Crawford. Presentation at Air Quality Symposium 2009, Fairbanks and North Star Borough, Fairbanks, AK. July 2009.

Analysis of the Effect of Fuel Chemistry and Properties on HCCI Engine Operation: A Re-Analysis Using a PCA Representation of Fuels. Bunting and Crawford. 2009. Draft Report (CRC Project AFVL13C)

The Chemistry, Properties, and HCCI Combustion Behavior of Refinery Streams Derived from Canadian Oil Sands Crude. Bunting, Fairbridge, Mitchell, Crawford, et al. 2008. (SAE 08FFL 28)

The Relationships of Diesel Fuel Properties, Chemistry, and HCCI Engine Performance as Determined by Principal Components Analysis. Bunting and Crawford. 2007. (SAE 07FFL 64).

Review and Critique of Data and Methodologies used in EPA Proposed Utility Mercury MACT Rulemaking, prepared by AEMS and RWCrawford Energy Systems for the National Mining Association. April 2004.

PCR+ in Diesel Fuels and Emissions Research. McAdams, Crawford, Hadder. March 2002. ORNL/TM-2002/16.

A Vector Approach to Regression Analysis and its Application to Heavy-duty Diesel Emissions. McAdams, Crawford, Hadder. November 2000. ORNL/TM-2000/5.

A Vector Approach to Regression Analysis and its Application to Heavy-duty Diesel Emissions. McAdams, Crawford, Hadder. June 2000. (SAE 2000-01-1961).

Reconciliation of Differences in the Results of Published Shortfall Analyses of 1981 Model Year Cars. Prepared by Energy and Environmental Analysis, Inc. for the U.S. Department of Energy under Contract DE-AC01-79PE-70045. October 1985

Short Test Results on 1980-1981 Passenger Cars from the Arizona Inspection and Maintenance Program. Darlington, Crawford, Sashihara. August 1984.

Seasonal and Regional MPG as Influenced by Environmental Conditions and Travel Patterns. Prepared by Energy and Environmental Analysis, Inc. for the U.S. Department of Energy under Contract DE-AC01-79PE-70045. March 1983.

Comparison of EPA and On-Road Fuel Economy – Analysis Approaches, Trends, and Impacts. McNutt, Dulla, Crawford, McAdams, Morse. June 1982. (SAE 820788)

Regionalization of In-Use Fuel Economy Effects. Prepared by Energy and Environmental Analysis, Inc. for the U.S. Department of Energy under Contract DE-AC01-79PE-70032. April 1982.

1985 Light-Duty Truck Fuel Economy. Duleep, Kuhn, Crawford. October 1980. (SAE 801387)

PROFESSIONAL AFFILIATIONS

Member, Society of Automotive Engineers.

HONORS AND AWARDS

2006 Barry D. McNutt Award for Excellence in Automotive Policy Analysis. Society of Automotive Engineers.

US Patent 7018524 (McAdams, Crawford, Hadder, McNutt). Reformulated diesel fuels for automotive diesel engines which meet the requirements of ASTM 975-02 and provide significantly reduced emissions of nitrogen oxides (NO_x) and particulate matter (PM) relative to commercially available diesel fuels.

US Patent 7096123 (McAdams, Crawford, Hadder, McNutt). A method for mathematically identifying at least one diesel fuel suitable for combustion in an automotive diesel engine with significantly reduced emissions and producible from known petroleum blend stocks using known refining processes, including the use of cetane additives (ignition improvers) and oxygenated compounds.

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235. Comment: **Robert Crawford's Resume**

Agency Response:
This is submittal three of three of Robert Crawford's resume to the ADF docket. It does not constitute an objection or suggestion on the proposal.

BEFORE THE
CALIFORNIA AIR RESOURCES BOARD

In re:	)
	)
Proposed Regulation on the Commercialization of Alternative Diesel Fuels (Public Hearing Scheduled for March 20, 2014)	)
	)

Declaration of James M. Lyons

I, James M. Lyons, declare and state as follows:

1. I am an engineer with training and expertise in motor vehicle fuels, automotive emissions control, and automotive air pollution. I am a Senior Partner of Sierra Research, Inc. ("Sierra"), an environmental consulting firm located at 1801 J Street, Sacramento, California. Sierra specializes in research and regulatory matters pertaining to air pollution control, and does work for both governmental and private sector clients. I have been employed at Sierra Research since 1991. I received a B.S. degree in Chemistry from the University of California, Irvine, and a M.S. Degree in Chemical Engineering from the University of California, Los Angeles. Before joining Sierra in 1991, I was employed by the State of California in the Mobile Source Division of the California Air Resources Board ("CARB").

I. Introduction, Qualifications, and Materials Considered

2. I have prepared this Declaration and the analysis it contains for Growth Energy. I hold the opinions expressed in this Declaration with a reasonable degree of engineering and scientific certainty. I plan to request an opportunity to testify before CARB at the public hearing scheduled for this matter, so that I may answer any questions concerning my opinions and the analysis and sources on which I have based those opinions. I also request that CARB review and

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respond to each part of the analysis and opinions presented in this Declaration before deciding what action to take on the CARB staff's proposed alternative diesel fuel ("ADF") regulation.

3. During my career, I have worked on many projects related to the following areas: (1) the assessment of emissions from on- and non-road mobile sources, including ships and locomotives; (2) analyses of the unintended consequences of regulatory actions; and (3) the feasibility of compliance with air quality regulations. I have also studied how the use of biodiesel fuels can influence exhaust emissions of oxides of nitrogen ("NOx") when used in vehicles and engines operated in California, and I have prepared and filed declarations regarding that issue in *POET LLC et al. v. California Air Resources Board*, an action in which I was a co-petitioner.

4. I have testified as an expert under state and federal court rules in cases involving CARB regulations for gasoline, Stage II vapor recovery systems and their design, combustion chamber system design, and issues related to emissions from heavy-duty vehicles and engines. While at Sierra I have acted as a consultant on automobile air pollution control matters for CARB and other governmental organizations. I am a member of the American Chemical Society and the Society of Automotive Engineers and have co-authored nine peer-reviewed monographs concerned with automotive emissions, including greenhouse gases and their control. In addition, over the course of my career, I have conducted peer-reviews of numerous papers related to a wide variety of issues associated with pollutant emissions and air quality. My résumé is attached as Attachment A.

5. I have reviewed a report being filed along with this Declaration by Growth Energy that has been prepared by Mr. Robert Crawford of Rincon Ranch Consulting, entitled *NOx Emissions Impact of Soy- and Animal-based Biodiesel Fuels: A Re-Analysis* (December

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2013). I have also studied the CARB Initial Statement of Reasons ("ISOR" or "Staff Report") released to support the proposed ADF regulation, and the studies cited in the ISOR that are pertinent to Mr. Crawford's analysis. The additional materials I have considered to prepare this Declaration are identified as references.

6. Mr. Crawford's report examines the empirical basis for the CARB staff's claims that the use of biodiesel in California is unlikely to warrant environmental mitigation, and that the use of biodiesel blends below the ten percent blend level (B10) in California pursuant to the proposed ADF regulation will not result in increases in NOx emissions.

7. Mr. Crawford's report applies generally accepted methods of data analysis and demonstrates expertise in the subject-matter of the report; Mr. Crawford is an expert in the field in which he opines in his report; and his report is the type of analysis on which experts in the field of automotive emissions control rely.

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II. Analysis and Opinions

A. Increases in NOx Emissions from Biodiesel Blends Below B10

8. As explained in detail in Mr. Crawford's report, a proper statistical analysis of the available emissions data relied upon by CARB staff in developing the proposed ADF regulation demonstrates that statistically significant increases in NOx emissions will result from biodiesel blends that contain less than ten percent biodiesel, including at the five percent level (B5) and below. In addition, Mr. Crawford's report demonstrates that NOx emissions increase in direct proportion of the amount of biodiesel in a blend and there is not, as CARB staff claims, a "threshold" below which biodiesel use in a blend will not increase NOx emissions. Given this, as I explain below in more detail, CARB staff should be proposing a Significance Level of zero, rather than ten percent, for biodiesel. Given the issues identified with the CARB staff analysis of

biodiesel impacts on NOx emissions by Mr. Crawford, CARB has no credible scientific basis upon which to adopt the ADF regulation as proposed with the biodiesel Significance Level set at ten percent.

9. CARB staff presents, in Figures B.2 and B.3 of the ISOR, regressions of all the available emissions data considered by CARB staff in developing the proposed ADF regulation. Based on Mr. Crawford's findings, the slopes of these regression lines can be used to calculate the increases in NOx emissions expected from the use of soy- and animal-based biodiesel as a function of biodiesel content in the blend. The values calculated for soy- and animal-based biodiesel at selected blends levels over the range from one percent to twenty percent are shown in Table 1.

Table 1
Expected Increases In NOx Emissions from Biodiesel
Use Based on Available Emissions Data Considered by CARB Staff

	Percentage Increase in NOx Emissions	
Biodiesel Blend Level %	Soy-Based	Animal-Based
1	0.2	0.09
2	0.4	0.18
3	0.6	0.27
4	0.8	0.36
5	1	0.45
10	2	0.90
20	4	1.80

10. As shown in Table 1, the magnitude of the NOx increase for animal-based biodiesel is approximately half that observed for soy-based biodiesel. As also shown in Table 1, the emissions data considered by CARB show that increases in NOx emissions between about one and two percent occur at the proposed B10 significance threshold.

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B. The "Effective Blend Level" Concept Provides No Assurance Against Increases in NOx Emissions Due to Biodiesel Use

11. The proposed ADF regulation relies on a concept called the "Effective Blend Level" (EB) for biodiesel to determine when mitigation would be required. The formula proposed by CARB staff for calculating the Effective Blend Level for biodiesel is found in proposed Section 2293.6(a) and is reproduced below.

$$EB = 100 \times \left[\frac{NBV - 0.5LN - 0.73RD - VM - 0.55AB}{TCV}\right]$$

As specified in Section 2293.6(a), the above formula is to be used to compute an annual average statewide value for the Effective Blend Level relative to the total volume of fuel used in compression ignition engines excluding alternative fuels such as natural gas and liquefied petroleum gas ("TCV") in the state during that year.

12. The calculation begins with establishing the net volume of biodiesel of all types used in California *excluding biodiesel used in blends of five percent or less* (NBV) — a step that has no scientific basis, as demonstrated by Mr. Crawford's analysis, and that, on its own, completely invalidates the use of the EB metric for the intended purpose. The NBV value is then further reduced by subtracting 50% of the volume of low NOx Diesel (LN) used statewide and 73% of the volume of renewable Diesel used statewide. The remainder is then further reduced by subtracting the volume of biodiesel of all types used in blends where steps have been taken to voluntarily mitigate NOx increases (VM) and then again by subtracting 55% of the volume of animal-based biodiesel (AB) to account for the smaller magnitude of the NOx emission increases observed with that fuel.[1] The final value is then divided by TCV (i.e., the total volume of fuel

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[1] Those voluntary mitigation measures are assumed to have been taken before the so-called "Significance Level" is reached and mitigation would be required under the staff's proposal. *See* ¶ 13.

used in compression ignition engines excluding alternative fuels such as natural gas and liquefied petroleum gas in the state during that year) and multiplied by 100 to yield the Effective Blend Level on a percentage basis.

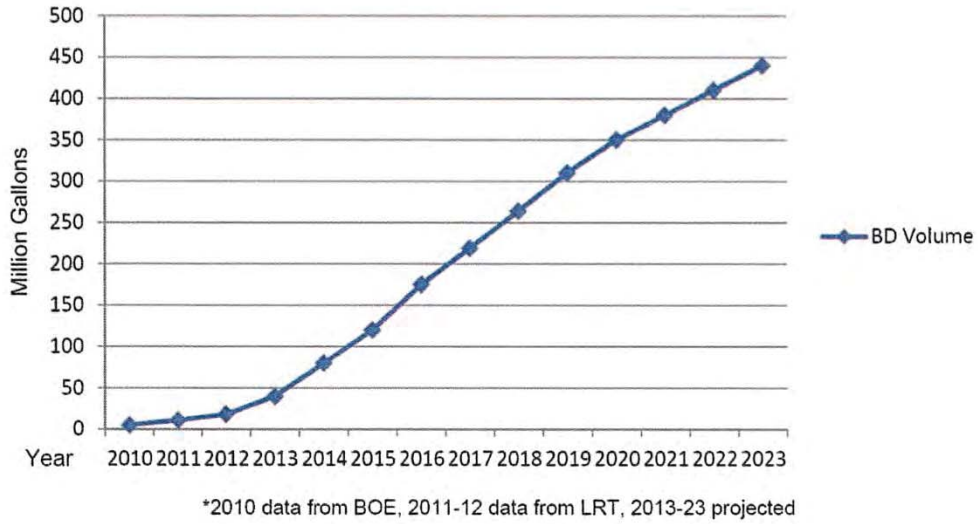
13. As specified in proposed Section 2293.5(c)(4), mitigation of NOx increases associated with biodiesel would be required only when the value of EB reaches 9.5 percent, which is 95% of the 10% Significance Level proposed for biodiesel.

14. There are a number of specific problems with the concept and calculation of the predicted Effective Blend Level that create the potential for significant increases in NOx emissions to result from the use of biodiesel in California; these are explained in detail below and should be addressed by CARB. As an initial matter, however, the overall problem with the EB concept will allow massive increases in the amount of biodiesel used in California without requiring any mitigation of the associated increase in NOx emissions. This can be seen readily by comparing CARB staff's projections of biodiesel use in California (Figure 6.2 of the ISOR) with CARB staff's projections regarding the Effective Blend Level for biodiesel (Figure 6.5 of the ISOR). Those two figures are reproduced below in Figure 1. As can been seen, despite the forecast nine-fold increase in annual biodiesel use in California from 50 million to 450 million gallons from 2013 to 2023 shown in Figure 6.2 of the ISOR, the forecast Effective Blend Level of biodiesel **decreases** to less than zero over virtually all of the period in question — meaning that, under the CARB staff's proposal, no mitigation of the increase in NOx emissions in California from biodiesel use will ever occur. CARB needs to confront and eliminate the EB concept from the staff's proposal, in light of this very simple demonstration of why the EB concept will not protect the environment against increases in NOx emissions.

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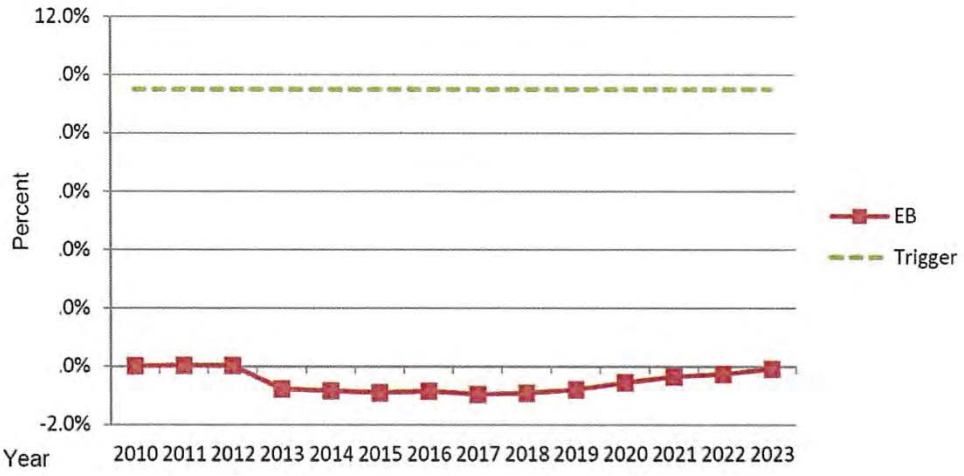
Figure 1. CARB Biodiesel Forecasts

Figure 6.2: Statewide Biodiesel Volume



*2010 data from BOE, 2011-12 data from LRT, 2013-23 projected

Figure 6.5: Effective Biodiesel Blend Level Forecast



Source: CARB Initial Statement of Reasons. Note that Figure 6.5 is reproduced directly from the ISOR, which is missing some increments on the y-axis.

15. Next, CARB needs to modify the proposed ADF regulation in order to address CARB staff's faulty assumption that biodiesel blends of up to five percent will have no impact on NOx emissions. With respect to five percent blends, CARB staff states on page ES-3 of the Staff

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Report that "biodiesel used in blends at B9 or below, including the B5 (B0 to B5) in predominant use today, does not increase NOx." The Staff Report also attempts to justify the exclusion of five percent blends from the EB calculation by arbitrarily excluding these blends from the ADF regulation. That assertion is undercut by the Staff Report's frank and correct admission on page 51 that "[g]iven the significant price premium for higher biodiesel blends such as B20 or B100, it is highly unlikely that operators of heavy-duty, legacy diesel fleets would opt to use the more expensive, higher biodiesel blends when comparable, lower cost conventional CARB diesel or B5 blends are readily available."

16. As noted above, Mr. Crawford's analysis demonstrates that statistically significant increases in NOx emissions will occur from the use of five percent biodiesel blends and, as Table 1 shows, the available emissions data relied upon by CARB staff indicate that at the five percent blend level, biodiesel use is expected to increase NOx emission by between about 0.5 and one percent. There is no doubt that unmitigated NOx emission increases of this magnitude have the potential to create significant adverse environmental impacts in areas of California with severe air quality problems.

17. It is also important for CARB to understand the import of the staff's prediction that biodiesel blends of five percent or less will be the primary means by which biodiesel will be used in California. As the Staff Report states on page 30:

> Staff has communicated with many of the stations that sell biodiesel as well as the major terminal operators in the state, and has found that the vast majority of the biodiesel currently being sold in California and expected to be sold in the future is sold as blends of B5 or less.

The fact that most biodiesel used in California will be sold as blends of five percent biodiesel or less, coupled with the fact that – as Mr. Crawford has explained – the available data show statistically significant increases in NOx emissions from such blends, means that biodiesel use in

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California under the proposed ADF regulation will result in unmitigated increases in NOx emissions. Again, the critical nature of the CARB staff's invalid assumption about the NOx impacts of blends at or below five percent simply cannot be ignored by CARB.

18. Even if it were correct that blends of B5 and less have no impact on NOx emissions, the EB calculation double-counts for the supposedly benign effect of those blends, and therefore makes mitigation even more unlikely. This can be illustrated by noting that CARB staff estimates that 450 million gallons per year of biodiesel will be used in California in 2023. (See Figure 6.2 of the Staff Report.) A recent California Energy Commission forecast[2] for total Diesel use in California in 2023 is about 4 billion gallons. On that basis, and without discounting for low NOx, renewable Diesel, or voluntary mitigation, the actual Effective Blend Level would be 11.25 percent and mitigation would be required for at least some biodiesel blends under the proposed ADF. Under CARB staff's approach, however, if a substantial portion of that biodiesel — for example, 50 percent — is five percent or lower blends, the Effective Blend Level drops to 5.6 percent and no mitigation of any kind is required for any biodiesel blends. That result is clearly incorrect, and the EB calculation must be modified to include, rather than exclude, B5 blends.

19. Another fundamental problem with the proposed EB calculation is that it is based on annual statewide average fuel use. NOx emissions have local and immediate impacts on air quality, with the questions of when and where they occur in the state being of critical importance with respect to the significance of those impacts. It follows directly that mitigation of NOx increases associated with biodiesel use must occur in the same area at the same time if air quality

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[2] See *http://www.energy.ca.gov/2011publications/CEC-600-2011-007/CEC-600-2011-007-SD.pdf*.

impacts are to be avoided. However, the EB completely fails to provide this assurance because CARB staff has either (1) ignored that reductions in NOx emissions from mitigation must take place at the same time and in the same area as NOx increases from biodiesel use, or (2) without support from anything in the rulemaking file, assumed that mitigation will occur in the same area and at the same time as the increases in NOx emissions.

20. To illustrate the problems the EB creates for mitigation, consider, for example, that under the proposed ADF regulation, increases in NOx emissions could occur from trucks operating on biodiesel in Los Angeles during August and exacerbate already high ambient ozone levels in that area. In turn, this increase in NOx emissions could be "mitigated" by reductions in NOx emissions from trucks operating on renewable diesel in the San Francisco area during December, when high ozone levels are not a problem. In this example, the EB concept would allow residents of Los Angeles to suffer adverse environmental impacts while the residents of San Francisco would realize no environmental benefit. Clearly the approach to mitigation designed into the EB concept by CARB staff makes no sense.

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C. CARB Staff's Assumption that Biodiesel Use Will not Increase Emissions from New Technology Diesel Engines Is Not Adequately Supported

21. In the Staff Report, CARB staff makes frequent statements regarding the impact of biodiesel on NOx emissions from "new technology diesel engines" (or "NTDEs"). For example, on page ES-3 of the ISOR, the staff states categorically that "use of biodiesel in 2010-compliant engines and other so-called 'New Technology Diesel Engines' does not increase NOx, regardless of the biodiesel blend level." Only one reference, Lammert et al.,[3] is provided in the staff report

[3] Lammert, M., McCormick, R., Sindler, P. and Williams, A., "Effect of B20 and Low Aromatic Diesel on Transit Bus NOx Emissions Over Driving Cycles with a Range of Kinetic Intensity," *SAE Int. J. Fuels Lubr.* 5(3):2012,

(Continued...)

to support this and other, analogous, statements by CARB staff. As CARB staff acknowledges, this single study involved chassis dynamometer testing of only two urban buses with NTDEs, with both engines being the same model produced by the same manufacturer. The extrapolation of that limited testing to the entire population of heavy-duty Diesel vehicles with NTDEs used in different applications and with different engine designs produced by a number of different manufacturers is simply not credible or reliable.

22. In addition, the CARB staff fails to acknowledge the following statement made by the authors of the Lammert study about the measurement of NOx emissions: "For much of the cycle[,] NOx would be at or near the detection limit of the laboratory equipment which resulted in a 95 percent confidence interval that was high relative to the value of the cycle emissions." That effect, which can be clearly seen in Figures 10 and 11 of the Lammert study, renders the claim that there was no statistically significant increase in NOx emissions observed from the use of biodiesel in NTDEs an artifact attributable to the lack of sensitivity of the NOx measurement instrumentation used in the study.

23. In sum, the CARB staff's unequivocal statements regarding the impact of biodiesel on NOx emissions from all vehicles with NTDEs is simply not reasonable based on data from (1) a single study that (2) that tested only two urban buses equipped with the same engine and (3) used instrumentation that was, at best, barely able to measure NOx emissions from the test vehicles in general, and clearly was not sensitive enough to reliably detect changes in NOx emissions due to use of different fuels. Nothing else in the rulemaking file supports the CARB staff's claim that there will not be increased NOx emissions from the use of biodiesel in NTDEs.

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I declare under penalty of perjury under the laws of California that the foregoing is true and correct to the best of my knowledge and belief.

Executed this 12th day of December 2013 at Sacramento, California.

James M. Lyons

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236. Comment: **Declaration of James M. Lyons**

Agency Response:
This is the second time this document was submitted by Growth Energy. It is a reproduction of comments **ADF B3-93** through **ADF B3-105**. The responses to these comments are in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

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Résumé

James Michael Lyons

Education

1985, M.S., Chemical Engineering, University of California, Los Angeles

1983, B.S., Cum Laude, Chemistry, University of California, Irvine

Professional Experience

4/91 to present — Senior Engineer/Partner/Senior Partner
Sierra Research

Primary responsibilities include oversight and execution of complex analyses of the emission benefits, costs, and cost-effectiveness of mobile source air pollution control measures. Mr. Lyons has developed particular expertise with respect to the assessment of control measures involving fuel reformulation, fuel additives, and alternative fuels, as well as accelerated vehicle/engine retirement programs, the deployment of advanced emission control systems for on- and non-road gasoline- and Diesel-powered engines, on-vehicle evaporative and refueling emission control systems, and Stage I and Stage II service station vapor recovery systems. Additional duties include assessments of the activities of federal, state, and local regulatory agencies with respect to motor vehicle emissions and reports to clients regarding those activities. Mr. Lyons has extensive litigation experience related to air quality regulations, product liability, and intellectual property issues.

7/89 to 4/91 — Senior Air Pollution Specialist
California Air Resources Board

Supervised a staff of four professionals responsible for identifying and controlling emissions of toxic air contaminants from mobile sources and determining the effects of compositional changes to gasoline and diesel fuel on emissions of regulated and unregulated pollutants. Other responsibilities included development of new test procedures and emission standards for evaporative and running loss emissions of hydrocarbons from vehicles; overseeing the development of the state plan to control toxic emissions from motor vehicles; and reducing emissions of CFCs from motor vehicles.

4/89 to 7/89 — Air Pollution Research Specialist
California Air Resources Board

Responsibilities included identification of motor vehicle research needs; writing requests for proposals; preparation of technical papers and reports; as well as monitoring and overseeing research programs.

9/85 to 4/89 — Associate Engineer/Engineer
California Air Resources Board

Duties included analysis of vehicle emissions data for trends and determining the effectiveness of various types of emissions control systems for both regulated and toxic emissions; determining the impact of gasoline and diesel powered vehicles on ambient levels of toxic air contaminants; participation in the development of regulations for "gray market" vehicles; and preparation of technical papers and reports.

Professional Affiliations

American Chemical Society
Society of Automotive Engineers

Selected Publications (Author or Co-Author)

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237. Comment: **James Lyons' Resume**

Agency Response: This is submittal three of three of James Lyons' resume to the ADF docket. It does not constitute an objection or suggestion on the proposal.

ATTACHMENT E

NOx Emission Impacts of Biodiesel Blends:
Technical Summary

Prepared by Robert Crawford
Rincon Ranch Consulting
Tucson, AZ 85730

October 20, 2014

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Issues Addressed

- Biodiesel NOx impact
  - How large is it?
  - Does it depend on dataset selection (which blend levels and studies to include)?
- Differences by blendstock type
  - Soy-based blends
  - Animal-based blends
- Emissions differences among animal-based feedstocks
- Are soy- and animal-based blends categorically different in their impact on NOx?
- Some implications for allowing biodiesels into California market

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References to Literature

Author	Title	Feedstocks Studied	Blends Studied
Clark 1999	Transient Emissions Comparisons of Alternative Compression Ignition Fuel	Soy	B20
McCormick 2002	Fuel Additive and Blending Approaches to Reducing NOx Emissions from Biodiesel	Soy, UCO	B20
McCormick 2005	Regulated Emissions from Biodiesel Tested in Heavy-Duty Engines Meeting 2004 Emissions	Soy, Canola, Animal	B20
Eckerle 2008	Effects of Methyl Ester Biodiesel Blends on NOx Emissions	Soy	B20
Nuszkowski 2009	Evaluation of the NOx emissions from heavy duty diesel engines with the addition of cetane improvers.	Soy	B20
Nikanjam 2010	Performance and emissions of diesel and alternative diesel fuels	Soy	B5, B20
Thompson 2010	Neat fuel influence on biodiesel blend emissions	Soy	B10, B20
Durbin 2011	Biodiesel Characterization and NOx Mitigation Study	Soy, Animal	B5, B10, B20
Durbin 2013A	CARB B5 Preliminary and Certification Testing	Animal	B5
Durbin 2013B	CARB B20 Biodiesel Preliminary and Certification Testing	Soy, UCO	B20
Karavalakis 2014	CARB Comprehensive B5/B10 Biodiesel Blends Heavy-Duty Engine Dynamometer Testing	Soy, Animal	B5, B10

1043

Datasets Used in Analysis

- ARB Individual Test Run Dataset ("raw data")
  - 4 tables: B5-soy, B10-soy, B5-animal, B10-animal
  - Individual test run measurements for the 3 UCR studies
  - Emission averages for other literature sources
- ARB Literature Dataset
  - Emission averages by engine, test cycle, and blend
  - Through B20 blend level
- We have added the following
  - Number of test replications for emission averages (estimated in some cases)
  - Cetane number for CARB Diesel, biodiesel blends, biodiesel feedstocks
  - Additional testing at B50 and B100 levels (where available).

1044

NOx Impact of Soy-based Biodiesels

1045

- The literature on soy-based blends is large and diverse (see Table 1):
  - 10 different studies (3 UCR studies sponsored by ARB)
  - 13 different vegetable feedstocks (10 soy, 2 UCO, 1 canola)
  - Conducted on a wide variety of engines in different labs
  - 7 different test cycles
- In spite of the diversity, the 3 UCR studies dominate the dataset.
  - The number of test replications (NReps) is used as a weighting factor in this analysis to reflect the better precision of results based on more tests.
  - When this is done, the UCR studies account for 82.5% of the literature dataset. The weight is even larger at the B5 and B10 levels, which come almost solely from the UCR studies.
- It is important to recognize that the effective diversity is less as a result of the weighting. The UCR studies examine only 3 different soy feedstocks.

1046

Table 1: Scope of Emissions Testing for Soy-based Biodiesel

	Clark 1999	McCormick 2002	McCormick 2005	Eckerle 2008	Nuszkowski 2009	Nikanjam 2010	Thompson 2010	Durbin 2011	Durbin 2013A/B	Karavalakis 2014
Biodiesel Feedstocks	Soy	Soy, UCO	Soy, Canola	Soy	Soy	Soy	Soy	Soy	Soy, UCO	Soy
Blend Levels Tested	B20	B20	B20	B20	B20	B5, B20	B10, B20	B5, B20, B50, B100	B5, B20	B5, B10
Engines Tested	One	One	Two	One	Three	One	One	Two On-Road Two Off-Road	One	Two
Test Cycles	FTP	FTP	FTP	FTP	FTP	FTP, ESC	FTP, ESC	FTP, UDDS, 40mph, 50mph, ISO 8178	FTP	FTP, SET, UDDS
Test Replications on Biodiesel	3	9	9	3	9	16	12	172	36	80

1047

NOx Impact of B5 Soy Blends Compared to CARB Diesel

- All B5 blends are soy-based
- The T-Test is the most direct method to assess the difference in mean NOx emissions (B5 vs. CARB Diesel) for individual engines
  - Requires that individual test runs (or standard deviations) be available. Cannot be applied to the Nikanjam data.
- B5 Soy blends clearly increase NOx emissions (see Table 2):
  - In 9 of 12 cases, NOx emissions are observed to increase
  - The NOx emission increases are statistically significant in 6 of the 9 cases (highly significant in 5 cases)
  - All NOx emission increases on the FTP cycle are statistically significant (when the test can be made)
  - None of the 3 observed NOx decreases is statistically significant.
- Conclusion: B5 Soy blends increase NOx emissions across a range of engines and test cycles.

1048

Table 2. T-Test Results for NOx Impact of B5 Soy-based Blends

Source	Feedstock ID	Engine	Cycle	NReps (total)	ΔNOx (gm/bhp-hr)	Prob > |t|	Statistical Significance
Nikanjam 2010	Soy	1991 DDC 60	FTP	8	T-Test not applied. Requires test runs or standard deviations.		
Nikanjam 2010	Soy	1991 DDC 60	ESC	8	T-Test not applied. Requires test runs or standard deviations.		
Durbin 2011	Soy #1	1999 Kubota TRU	ISO 8178-4 C	19	+ 0.084	p = 0.41	Not significant
Durbin 2011	Soy #1	2006 Cummins ISM	40mph Cruise	5	+ 0.034	p = 0.14	Not significant
Durbin 2011	Soy #1	2006 Cummins ISM	50mph Cruise	12	- 0.020	p = 0.59	Not significant
Durbin 2011	Soy #1	2006 Cummins ISM	FTP	39	+ 0.046	p < 0.001	Highly significant
Durbin 2011	Soy #1	2007 MBE4000	FTP	12	+ 0.011	p = 0.001	Highly significant
Durbin 2013A	Soy #2	2006 Cummins ISM	FTP	12	+ 0.026	p = 0.002	Highly significant
Karavalakis 2014	Soy #3	1991 DDC 60	FTP	16	+ 0.045	p < 0.001	Highly significant
Karavalakis 2014	Soy #3	1991 DDC 60	SET	8	- 0.030	p = 0.36	Not significant
Karavalakis 2014	Soy #3	1991 DDC 60	UDDS	16	+ 0.035	p = 0.05	Significant
Karavalakis 2014	Soy #3	2006 Cummins ISM	FTP	16	+ 0.021	p < 0.001	Highly significant
Karavalakis 2014	Soy #3	2006 Cummins ISM	SET	8	- 0.011	p = 0.16	Not significant
Karavalakis 2014	Soy #3	2006 Cummins ISM	UDDS	17	+ 0.066	p = 0.23	Not significant

Note: The t-test analysis uses the ARB dataset of individual test runs ("raw data")

1049

Composite NOx Impact of B5 Soy Blends Compared to CARB Diesel

- To estimate a composite impact across engines, a different statistical approach is needed that will account for the varying NOx emission levels of the engines and test cycles.
- Weighted regression analysis with dummy variables for N-1 engine/test cycle combinations "*i*" has been used to estimate Regression Model 1:

$$\log NOx = a + \sum_{i=2}^{N} \delta_i + b \cdot \delta_{B5}$$

where:

  - Coefficients a and δ_i represent the average log *NOx* emission level on CARB Diesel for each engine/test cycle combination. (These values are not reported in the summary of results that follows.)
  - δ_{B5} = 0 for CARB Diesel tests; δ_{B5} = 1 for B5 Soy tests
  - Coefficient b gives the composite NOx impact of B5 Soy across engines/test cycles.
- The log *NOx* formulation assumes that the emissions impact on a percentage basis is proportional to blend level. The percentage impact on NOx emissions equals $100 \cdot [\exp(b)-1]$

1050

Result for Composite B5 Soy Impact on NOx

- Based on the ARB test run dataset ("raw data")
  - The Nikanjam 2010 B5 testing (with weight of 4 for its NOx averages) can be included with the UCR testing (with weight of 1 for each test run).
- Regression Model 1 Result:
  - R^2 = 0.9995 (dominated by the dummy variables that represent the differing NOx emission levels among engines and test cycles)
  - Coefficient b for the δ_{B5} effect has the value: +0.0096 ± 0.0026. The statistical significance is p = 0.0003 (highly significant).
- The equivalent percentage NOx increase is **+0.96%** at the B5 level
  - or 0.19% for each 1 percent biodiesel in a blend.

1051

Composite NOx Impact of Soy Blends Through B10

- To assess the composite NOx impact through B10, the regression model is modified to use blend level as the predictive variable. Here, the revised model is fit using the subset of data where individual tests are available ("raw data").
- Unweighted regression analysis with dummy variables for N-1 engine/test cycle combinations "*i*" has been used to estimate Regression Model 2:

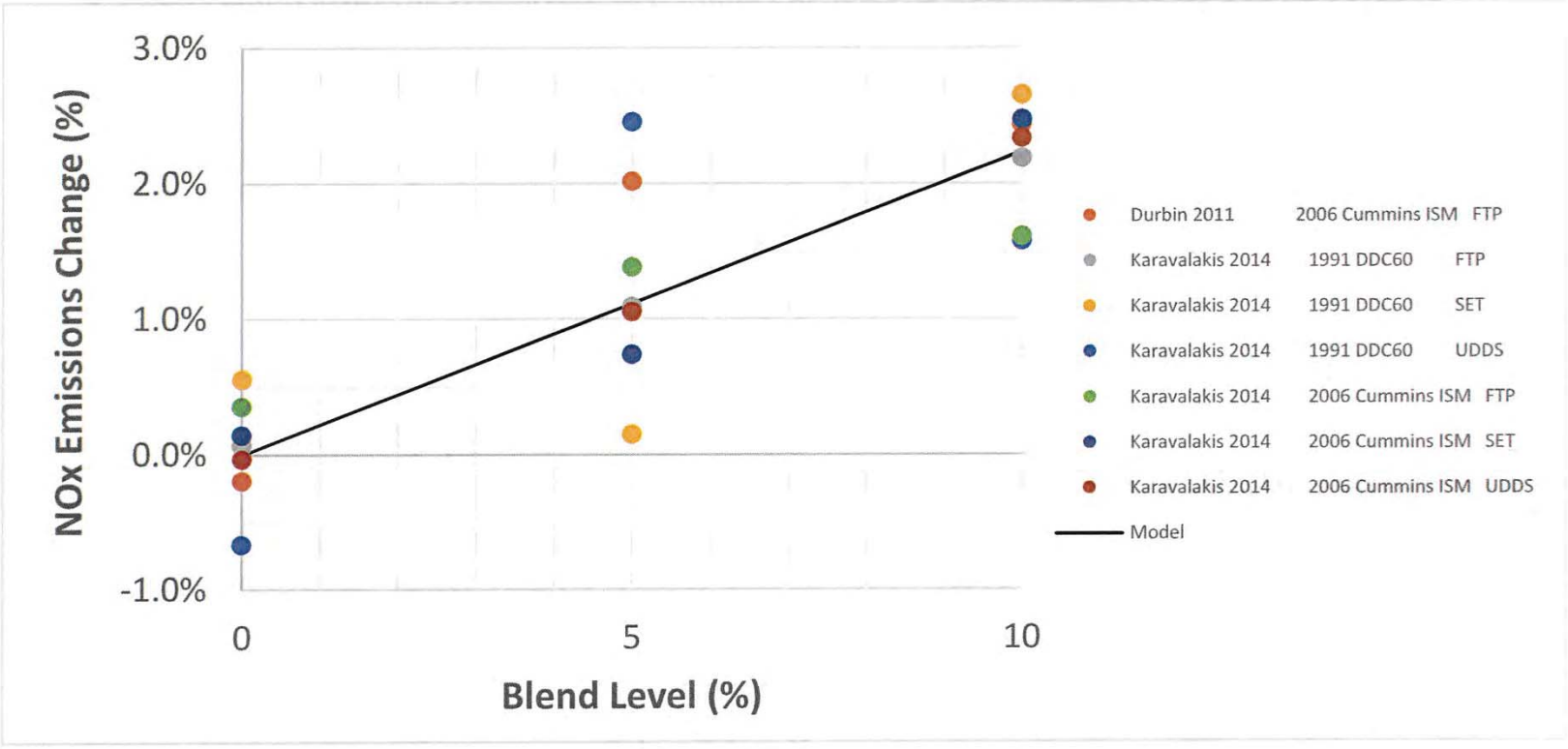
$$\log NOx = a + \sum_{i=2}^{N} \delta_i + b \cdot BioPct$$

where:

- Coefficients a and δ_i represent the average log *NOx* emission level on CARB Diesel for each engine/test cycle combination. (These values are not reported in the summary of results that follows.)
- BioPct is the blend level (percentage biodiesel in the blend). CARB Diesel is BioPct = 0; B5 is BioPct = 5.
- Coefficient b gives the composite NOx impact across engines/test cycles for each 1 percent biodiesel in a blend.

1052

Soy biodiesels cause statistically significantly increases in NOx emissions at B10, B5 and Lower blend levels



NOx Impact of Vegetable Biodiesels At Higher Blend Levels

- To include more sources, blends and feedstocks, we shift to analysis of the literature dataset with blend levels above B5. NOx emissions are reported as averages on CARB Diesel and for each BioPct blend level tested.
- Regression Model 2 is fit using emission averages weighted by the number of replications on each blend:

$$\log NOx = a + \sum_{i=2}^{N} \delta_i + b \cdot BioPct$$

where:

- Coefficients a and δ_i represent the average log *NOx* emission level on CARB Diesel for each engine/test cycle combination. (These values are not reported in the summary of results that follows.)
- BioPct is the blend level (percentage biodiesel in the blend). CARB Diesel is BioPct = 0; B5 is BioPct = 5.
- Coefficient b gives the composite NOx impact across engines/test cycles for each 1 percent biodiesel in a blend.

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Composite Soy Impact on NOx at Higher Blend Levels

- Including all data through B100 gives the greatest diversity in sources, blends and feedstock.
- Result:
  - $R^2 = 0.9990$ (dominated by the dummy variables that represent the differing NOx emission levels among engines and test cycles)
  - Regression coefficient b for the BioPct effect has value: +0.00220 ± 0.00016. The statistical significance is $p < 0.0001$ (highly significant).
- The equivalent percentage NOx increase is **+1.10%** at the B5 level
  - Or, 0.22% for each 1 percent biodiesel in a blend.
- This result is nearly the same as given by the regression analysis of the individual runs dataset through B5.

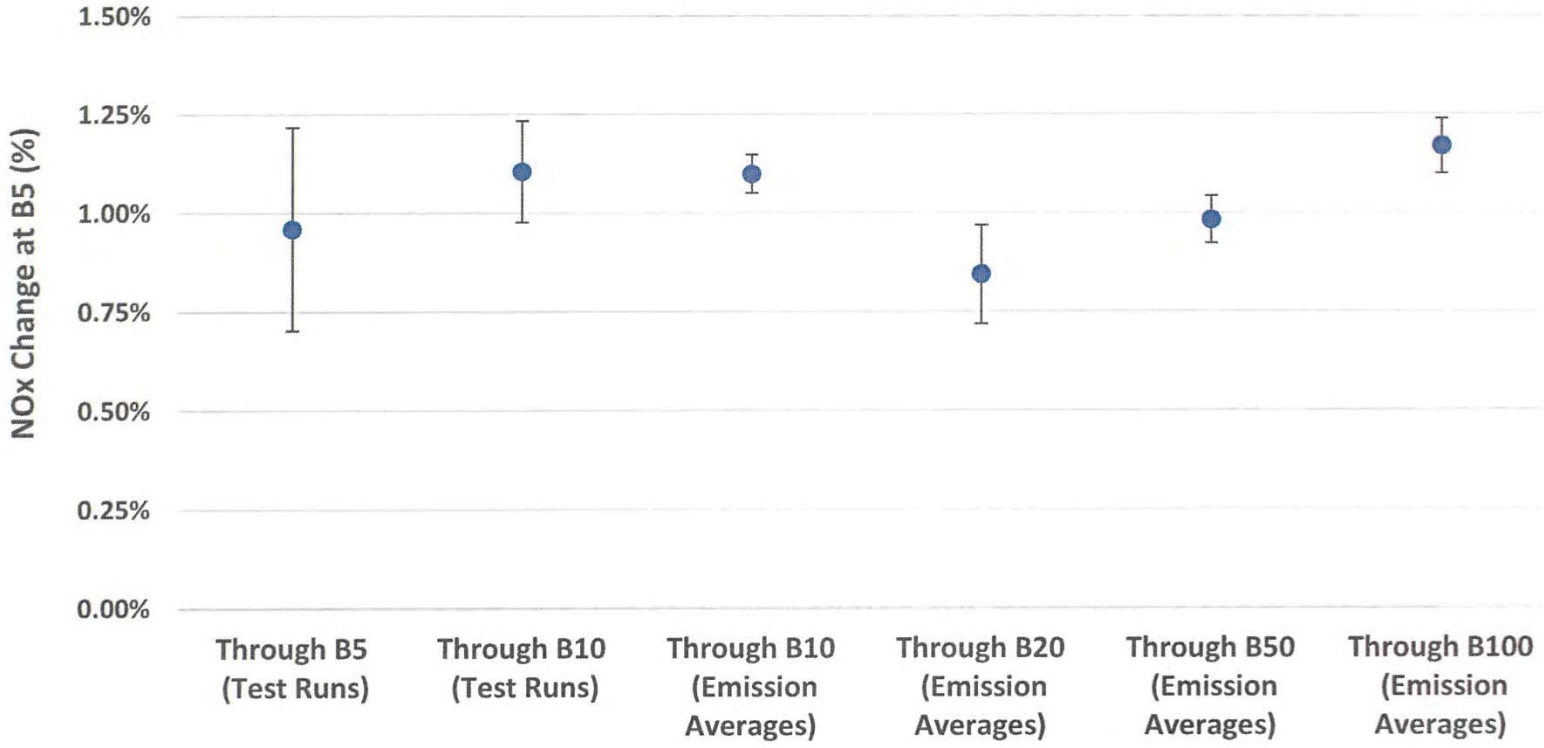
1055

Composite Soy Impact on NOx at Higher Blend Levels

- The composite soy impact is also robust with respect to data selection (see Figure 1)
- Different choices for the dataset (test runs versus emissions averages) and the highest blend level to include (through B10, through B20, through B50, and through B100) give different results for the NOx slope with BioPct blending level. However, the results all fall within the errors bars of the estimate based on the B5 test runs alone.
- This indicates that the NOx response is linear with BioPct through high blend levels and that systematic differences among the studies are not large.
- Statistical tests show no difference among soy, UCO, and canola in their NOx impact. However, the UCO and canola samples are small and capable of detecting only large differences.

1056

Figure 1: The NOx Impact of B5 Soy as a Function of Dataset Selection



Conclusions for Soy-based Biodiesels

- Soy biodiesel increases NOx emissions by amounts that can be estimated with good statistical confidence.
- NOx will increase ~1% on average at the B5 level and ~2% at B10.
- The NOx response is linear with the BioPct blend level. There is no threshold level where soy biodiesel does not increase NOx.
- This result is supported by all of the available studies and data (none disagree substantially)
  - Individual blends, engines and test cycles may still vary to some extent.
- NOx increases may be expected for UCO, canola and other vegetable biodiesels, but the data are very limited.

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NOx Impact of Animal-based Biodiesel

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- The literature on animal-based blends is much smaller than for soy (see Table 3):
  - Only 4 studies (3 UCR studies sponsored by ARB)
  - Only 4 animal feedstocks in total
  - Conducted primarily on engines at UCR CE-CERT (only 6 test replications conducted elsewhere)
  - A variety of test cycles
- The 3 UCR studies dominate the animal-blend dataset to a greater extent than for soy:
  - Counting test replications, the UCR studies account for 97.5% of the dataset. All of the data at the B5 and B10 levels comes from the UCR studies.
- There are notable differences among the four studies on the size of the NOx impact and its relationship to BioPct.
  - *The available studies may not permit a reliable, general understanding of the impacts of animal-based feedstocks.*

1060

Table 3: Scope of Emissions Testing for Animal-based Biodiesels

	McCormick 2005	Durbin 2011	Durbin 2013A	Karavalakis 2014
Biodiesel Feedstock	Animal #1	Animal #2	Animal #3	Animal #4
Blend Levels Tested	B20	B5, B20, B50, B100	B5	B5, B10
Engines Tested	2 on-road	3 on-road, 1 off-road	1 on-road	1 on-road
Test Cycles	FTP	FTP, UDDS, 50 mph, ISO 8178	FTP	FTP, SET, UDDS
Test Replications on Biodiesel	6	126	26	80
NOx Increase Observed?				
At / Below B10	–	Yes	No	No
Above B10	Yes	Yes	–	–

1061

NOx Impact of B5 Animal Compared to CARB Diesel

- The T-Test is the most direct method to assess differences in mean NOx levels between B5 and CARB Diesel for individual engines.
- The McCormick 2005 study tested the Animal #1 feedstock at the B20 level and found a statistically significant increase in NOx, but did not test at the B5 level considered here.
- Table 4 reports this comparison for animal-based biodiesels. Results:
  - Animal #2 *increases* NOx in 2 of 3 engines. The increase is highly significant for 1 engine.
  - Animal #3 *decreases* NOx in one engine. The increase is statistically significant at the p=0.05 level. The blend was certified as NOx neutral at B5.
  - Animal #4 *increases* NOx in 3 of 6 cases and *decreases* NOx in the other 3 cases. The results are inconclusive as none of the changes are statistically significant. The blend may or may not change NOx.

1062

T-Test for NOx Impact of B5 Animal Blends

Source	Feedstock ID	Engine	Cycle	NReps (total)	ΔNOx (gm/bhp-hr)	Prob > |t|	Statistical Significance
Durbin 2011	Animal #2	2006 Cummins ISM	FTP	12	+ 0.0067	p = 0.29	Not Significant
Durbin 2011	**Animal #2**	**2007 MBE4000**	**FTP**	**12**	+ 0.0168	p < 0.001	Highly Significant
Durbin 2011	Animal #2	2009 John Deere	ISO 8178	13	- 0.0342	p = 0.21	Not Significant
Durbin 2013A	**Animal #3**	**2006 Cummins ISM**	**FTP**	**52**	- 0.0072	p = 0.054	Significant
Karavalakis 2014	Animal #4	1991 DDC 60	FTP	16	+ 0.0031	p = 0.81	Not Significant
Karavalakis 2014	Animal #4	1991 DDC 60	SET	8	+ 0.0095	p = 0.77	Not Significant
Karavalakis 2014	Animal #4	1991 DDC 60	UDDS	16	- 0.1119	p = 0.31	Not Significant
Karavalakis 2014	Animal #4	2006 Cummins ISM	FTP	16	- 0.0073	p = 0.61	Not Significant
Karavalakis 2014	Animal #4	2006 Cummins ISM	SET	8	+ 0.0025	p = 0.90	Not Significant
Karavalakis 2014	Animal #4	2006 Cummins ISM	UDDS	16	- 0.0993	P = 0.16	Not Significant

Notes: The t-test analysis uses the ARB dataset of individual test runs ("raw data")

1063

NOx Impact of Animal Biodiesels Through B10

- Only Karavalakis 2014 reports testing on B5 and B10 to support an assessment of NOx impacts through B10. This involves a single animal feedstock (Animal #4) and cannot be generalized to a wider range of biodiesels.
- The analysis is based on Regression Model 2 which is linear in BioPct.
- For Animal #4, the NOx trend with BioPct is relatively flat through B10 (see Table 5).
  - The NOx slope is positive (NOx is increased) in 3 of 6 cases and negative (NOx is decreased) in 3 of 6 cases.
  - One slope (1991 DDC 60 on SET cycle) is positive and statistically significant.
- Conclusion: Animal #4 increases NOx through B10 in at least one engine and test cycle.

1064

Table 5. NOx Trend Results Through B10 for An Animal Feedstock

Regression Model 2: $\log NOx = a + \sum_{i=2}^{N} \delta_i + b \cdot BioPct$

Source	Feedstock ID	Engine	Cycle	BioPct Slope (B) (gm/bhp-hr per % Biodiesel)	Prob > |t|	Statistical Significance
Karavalakis 2014	Animal #4	1991 DDC 60	FTP	+ 0.0012	p = 0.33	Not Significant
Karavalakis 2014	Animal #4	1991 DDC 60	SET	+ 0.0069	p = 0.05	Significant
Karavalakis 2014	Animal #4	1991 DDC 60	UDDS	- 0.0051	p = 0.67	Not Significant
Karavalakis 2014	Animal #4	2006 Cummins ISM	FTP	- 0.0006	p = 0.59	Not Significant
Karavalakis 2014	Animal #4	2006 Cummins ISM	SET	+ 0.0006	p = 0.77	Not Significant
Karavalakis 2014	Animal #4	2006 Cummins ISM	UDDS	- 0.0088	p = 0.19	Not Significant

Note: The regression analysis uses the ARB dataset of individual test runs ("raw data").

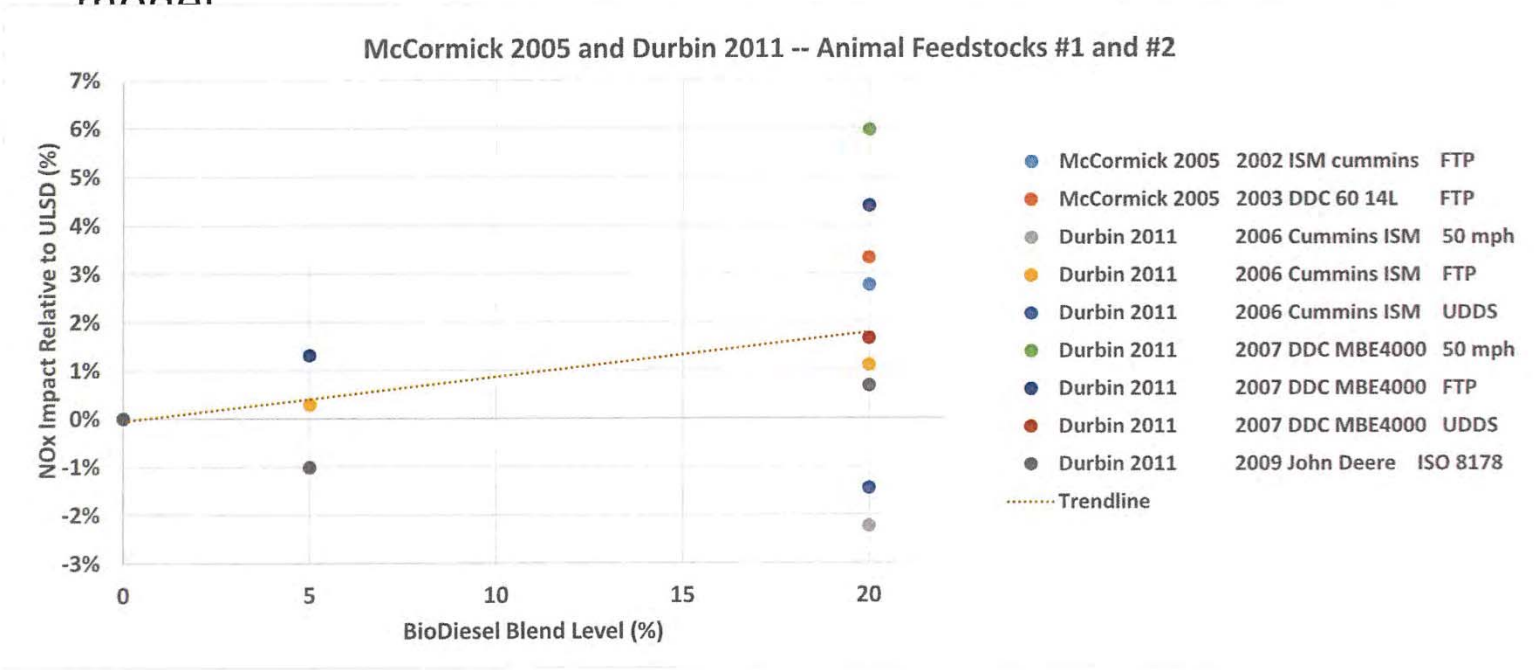
1065

NOx Impact of Animal Biodiesels Through B20

- To include more sources, blends and feedstocks, we shift to analysis of the literature dataset. NOx measurements are reported as averages on CARB Diesel and for each BioPct blend level tested.
- Only graphical analysis is presented through B20 because most sources tested only two blend levels per feedstock (so regression analysis is not useful).
- As the following charts show, the latest ARB studies show substantially lower NOx impacts than the earlier studies and no clear trend with BioPct blend level.
- Each study tested a different animal feedstock. We interpret these results as indicating that the NOx impact can vary in important ways from one animal feedstock to another.

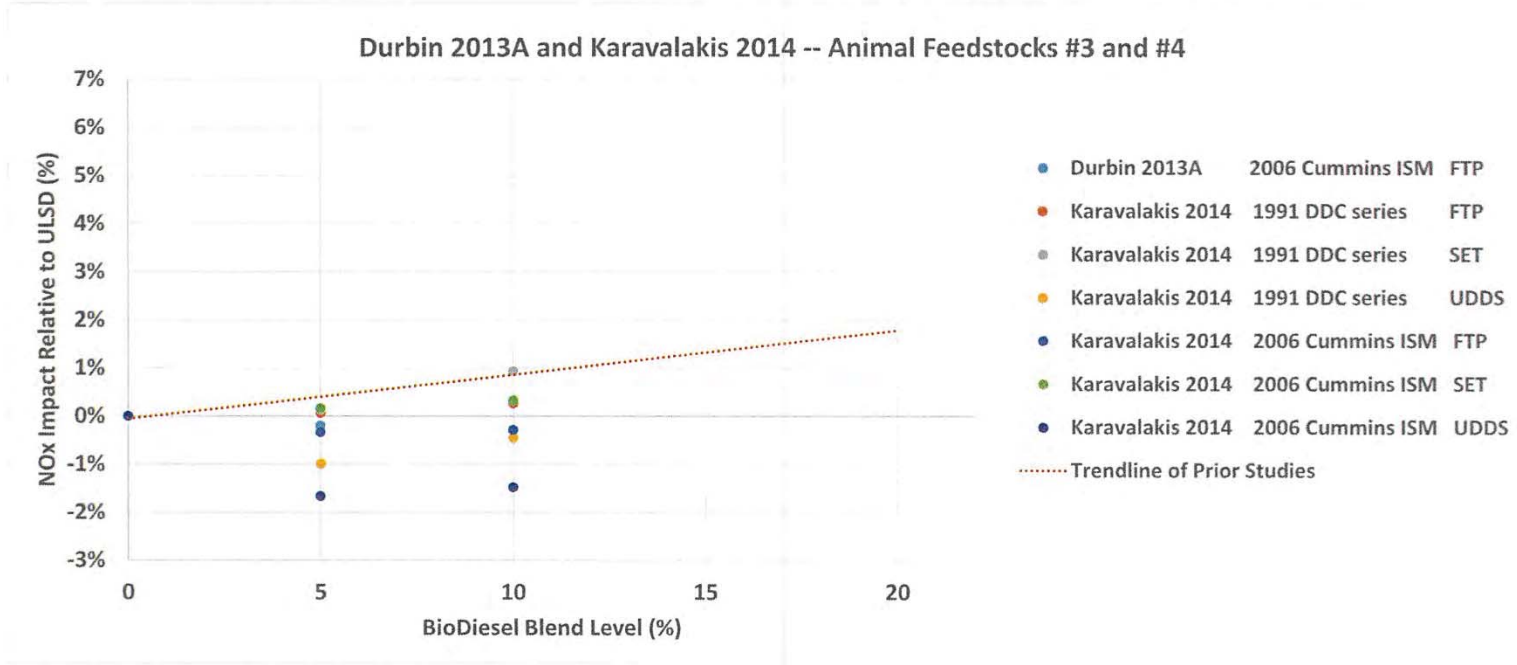
1066

- In the first two studies of animal-based biodiesel:
  - NOx is significantly increased at B20
  - A smaller increase is observed at B5 consistent with a linear model



1067

- In the two most-recent studies of animal-based biodiesel:
  - No appreciable NOx increase is observed through B10
  - NOx impacts are below the trendline of the two prior studies



1068

What is the Composite NOx Impact for Animal-based Biodiesel?

- It depends on the blend level range that is considered
- This choice determines the influence given to each study and animal feedstock in the estimate.
- Including higher blending levels (more studies, more feedstocks) gives a better ability to resolve the slope with blend level and may yield a more general result.
- Including only lower blending levels reduces the number of feedstocks and blends considered. Results may not be general.

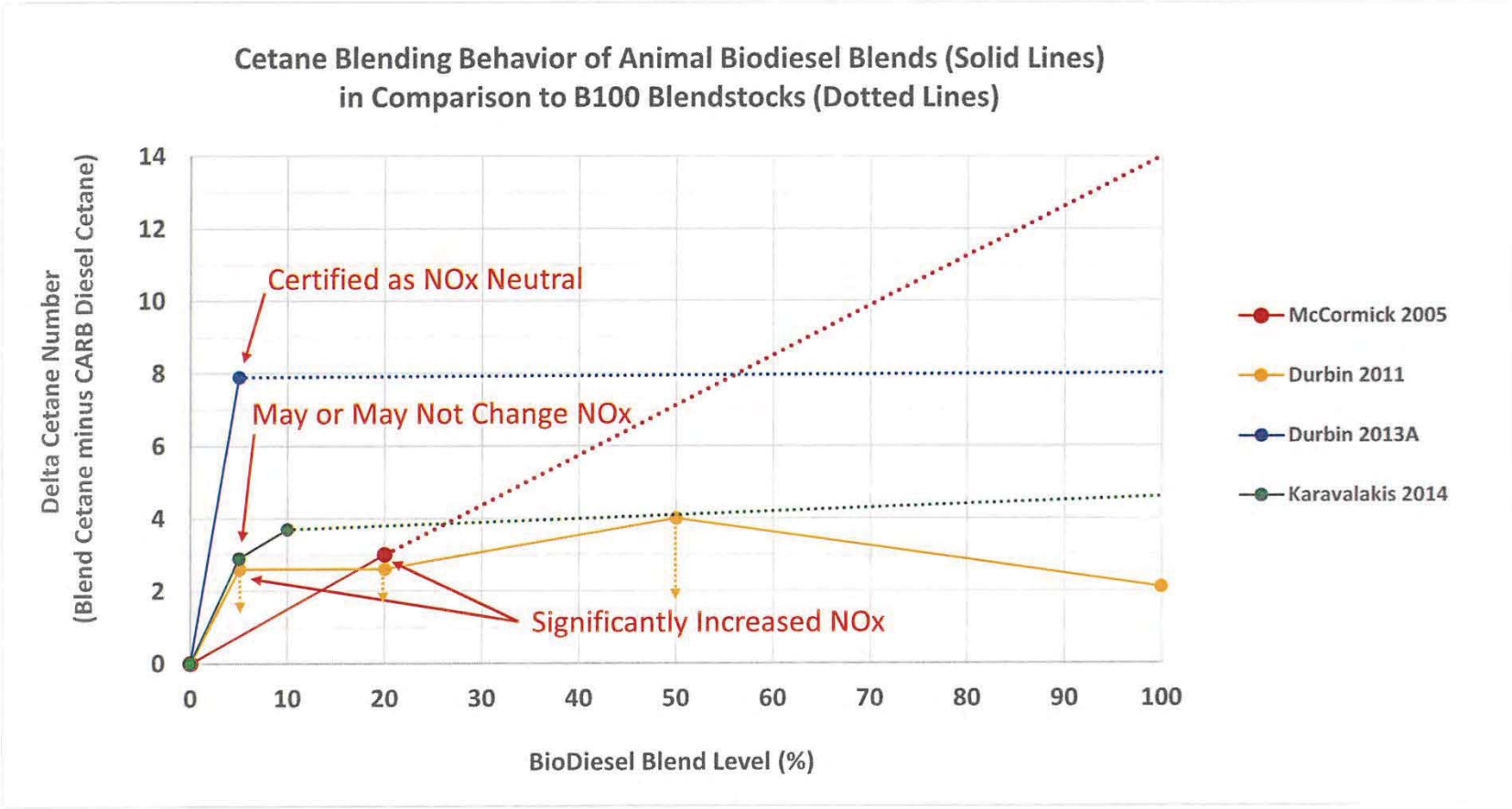
	Highest Blend Level Considered			
	B10	B20	B50	B100
Weight Given to Studies				
McCormick 2005	0%	2%	2%	2%
Durbin 2011	15%	59%	63%	67%
Durbin 2013A	21%	10%	9%	8%
Karavalakis 2014	65%	30%	27%	24%
Composite BioPct Slope				
ΔNOx (%) per 1% Biodiesel	- 0.03%	+ 0.05%	+ 0.29%	+ 0.16%
Standard Error of Estimate	± 0.03%	± 0.03%	± 0.09%	± 0.06%
Prob > |t|	p = 0.35	p = 0.15	p < 0.01	p = 0.01
Statistically Significant?	No	No	Yes	Yes

1069

A Better Understanding of Cetane Effects is Needed

- The higher cetane number of animal feedstocks is a likely reason that animal-based blends have lower NOx impacts than soy-based blends.
- Cetane is complicated and may or may not blend linearly with volume.
- The following chart shows that all of the UCR animal-based blends have a large cetane benefit, achieving most (or all) of the B100 cetane at low blend levels.
  - Lab differences could be involved. Durbin 2011 measured cetane for the blends at CE-CERT, while cetane for CARB Diesel and B100 was determined by an outside lab.
  - The large cetane boosts at low blend levels help to offset NOx increases.
- The McCormick 2005 animal feedstock behaves differently, with cetane blending linearly with BioPct in the B20 blend. The cetane benefit of this feedstock expected at the B5 level is small compared to the three UCR feedstocks.
- *What is the evidence that the rapid cetane boost observed for the UCR blends is real and representative of the cetane behavior of animal feedstocks available in the California market?*

1070


Cetane Blending Behavior of Animal Biodiesel Blends (Solid Lines)
in Comparison to B100 Blendstocks (Dotted Lines)
Delta Cetane Number
(Blend Cetane minus CARB Diesel Cetane)
14
12
10
8
6
4
2
0
0
10
20
30
40
50
60
70
80
90
100
BioDiesel Blend Level (%)
Certified as NOx Neutral
May or May Not Change NOx
Significantly Increased NOx
McCormick 2005
Durbin 2011
Durbin 2013A
Karavalakis 2014

1071

What Do We Know About the Animal-based blends?

- Not enough to fully understand the emissions results. ARB should release all available information on its animal feedstocks and blends, including the distillation curves and the FAME and oxygen content analysis (if performed).
- ARB should clarify how it has determined cetane number in the 3 UCR studies and confirm its animal-blend cetane numbers with outside testing.

	McCormick 2005	Durbin 2011	Durbin 2013A	Karavalakis 2014
Feedstock Description	Beef Tallow	Animal	Animal Tallow	Animal
B100 Cetane Number	65	57.9	61.1	58.0
Flash Point (°C)	159	164	144	165
Cloud Point (°C)	14	13	15	–
Kinematic Viscosity 40C (mm^2/s)	4.71	4.41	4.691	4.714
Specific Gravity	0.8754	–	0.8750	0.875
API Gravity	–	28.5	30.2	30.3
Distillation T90 (°C)	351	348	352	Not Reported
Iodine Number	56	Not Reported	Not Reported	Not Reported

1072

Conclusions on NOx Impact of Animal-based Biodiesel Blends

- Animal-based biodiesels have smaller NOx impacts than soy-based blends. The tendency of animal feedstocks to increase cetane is a likely reason.
- The animal-blends dataset is much more limited than for soy, with only four different feedstocks examined in the entire literature.
- There is disagreement among the studies on the NOx impact of B5 animal blends:
  - One B5 blend has significantly increased NOx on one engine and test cycle.
  - One B5 blend has been certified as NOx neutral on one engine and test cycle.
  - Other B5 blends may or may not increase NOx depending on engine and test cycle
- We need to understand the cetane behavior in the UCR blends and what is representative of animal biodiesels in California before more general conclusions can be drawn for animal-based blends.

1073

The Influence of Cetane on Biodiesel NOx Impacts

Cetane is a Key Driver of the NOx Impact for Biodiesel

- This section presents an analysis that demonstrates that soy- and animal-based blends are not categorically different once their differing effect on blend cetane is accounted for.
  - Soy-based feedstocks have more unsaturated carbon bonds and tend to reduce cetane below that of CARB Diesel, although some soy and other vegetable feedstocks can increase cetane.
  - Animal-based feedstocks are more highly saturated and tend to increase cetane above that of CARB Diesel in most cases.
- When a cetane term is added, soy- and animal-based blends can be represented by the same model.
- The preliminary analysis indicates a method of predicting which biodiesel blends will have the greatest impact on NOx emissions.

1076

Cetane-based Model of the Biodiesel NOx Impact

- The analysis uses the complete literature dataset – all blends at blending levels through B20 – in a modified regression analysis.
- Regression Model 3 is fit using emission averages weighted by the number of replications on each blend:

$$\log NOx = a + \sum_{i=2}^{N} \delta_i + b \cdot BioPct + c \cdot \Delta Cetane$$

where:

- Coefficients a and δ_i represent the average log *NOx* emission level on CARB Diesel for each engine/test cycle combination. (These values are not reported in the summary of results that follows.)
- BioPct is the blend level (percentage biodiesel in the blend). CARB Diesel is BioPct = 0; B5 is BioPct = 5.
- ΔCetane is the change in cetane number of the blend compared CARB Diesel
- Coefficient b gives the composite NOx impact across engines/test cycles for each 1 percent biodiesel in a blend at constant cetane (i.e., ΔCetane = 0).
- Coefficient c gives an adjustment to NOx emissions in proportion to ΔCetane.

1077

Result for Cetane-based Model of Biodiesel NOx Impacts

- Result: $R^2 = 0.9948$ (dominated by the dummy variables that represent the differing NOx emission levels among engines and test cycles)

Coefficient	Estimate	Prob > |t|	Statistical Significance
b	+ 0.00156	p < 0.0001	Highly Significant
c	- 0.00303	p < 0.0001	Highly Significant

- The NOx increase is 0.16% for each 1 percent biodiesel in a blend, or 0.8% for B5 at constant cetane.
  - Soy blends have an additional, adverse cetane effect on average that increases the NOx impact to ~1%.
  - Animal blends tend to increase Cetane, so have reduced NOx impacts in comparison.

1078

Result for Cetane-based Model of Biodiesel NOx Impacts

- The *c* coefficient estimates that +5 Cetane Numbers will decrease NOx emissions by 1.5%.
  - Other work* also finds a 1.5% NOx reduction for +5 Cetane Numbers in base blends with Cetane levels of ~50.
- An increase of $-b/c = 0.5$ Cetane Numbers is needed to offset the NOx increase expected from each 1% biodiesel added. For B5, an increase of 2.5 Cetane numbers is required to offset the NOx increase.
- Statistical tests of the residuals indicate that the model explains all of the observed differences among biodiesel types (animal, soy, UCO, canola) and among studies.

1079

* *The Effect of Cetane Number Increase Due to Additives on NOx Emissions from Heavy-Duty Highway Engines.* EPA420-R-03-002. February 2004. Figure IV.A.-1.

NOx Emission Changes At Constant Cetane

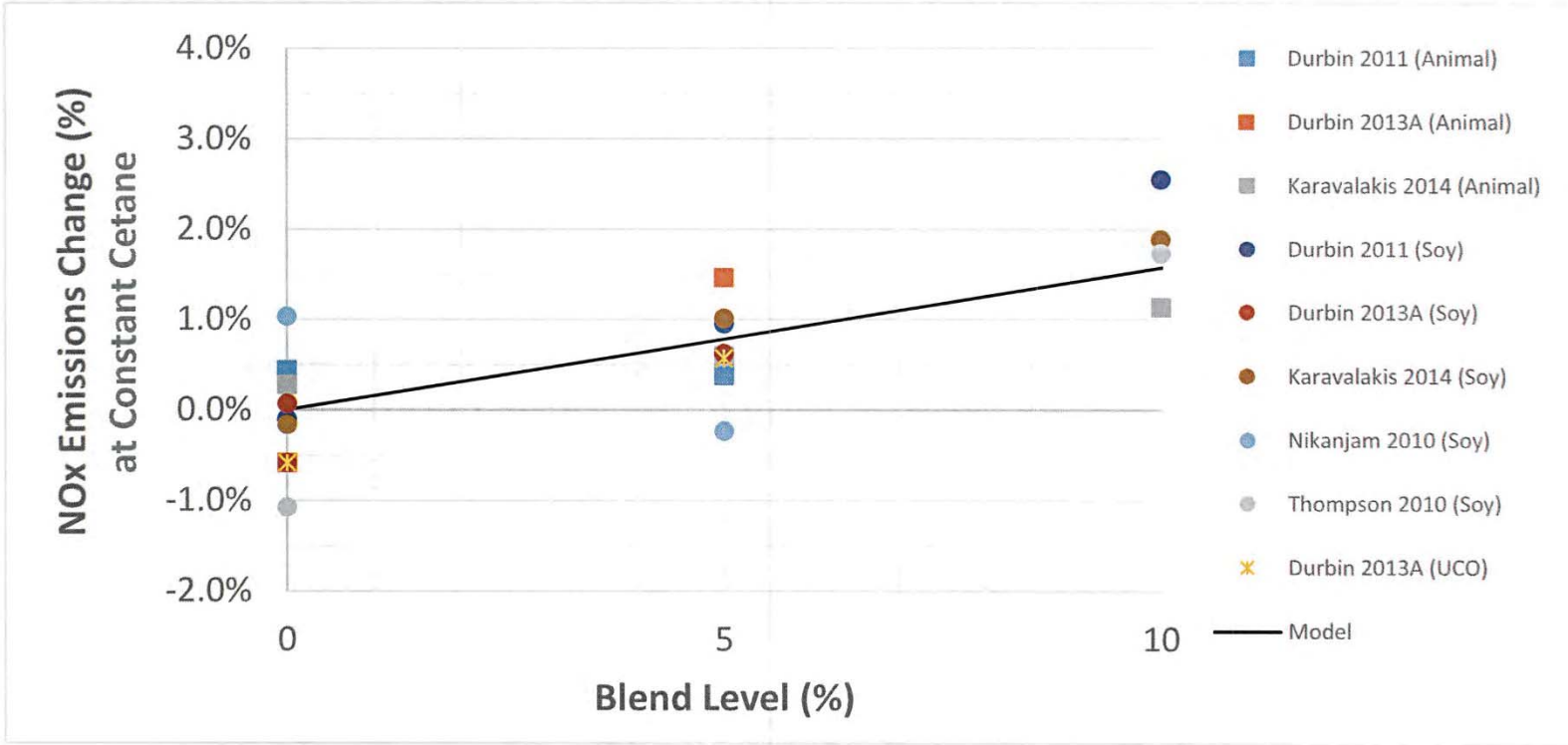
- The *c* coefficient can be used to remove the effect of cetane changes from the measured NOx emission values. The adjustment takes each biodiesel blend back to the cetane number of the CARB diesel used as the base blend in its testing.
- For each combination *i* (study, feedstock, engine, and test cycle), the percent change in NOx emissions at blend level *j* can be estimated as follows:

$$\Delta NOx_{i,j} = \exp\left[\ln NOx_{i,j} - (a_i + \sum_{i=2}^{N} \delta_i) - c \cdot \Delta Cetane_i\right] - 1$$

1080

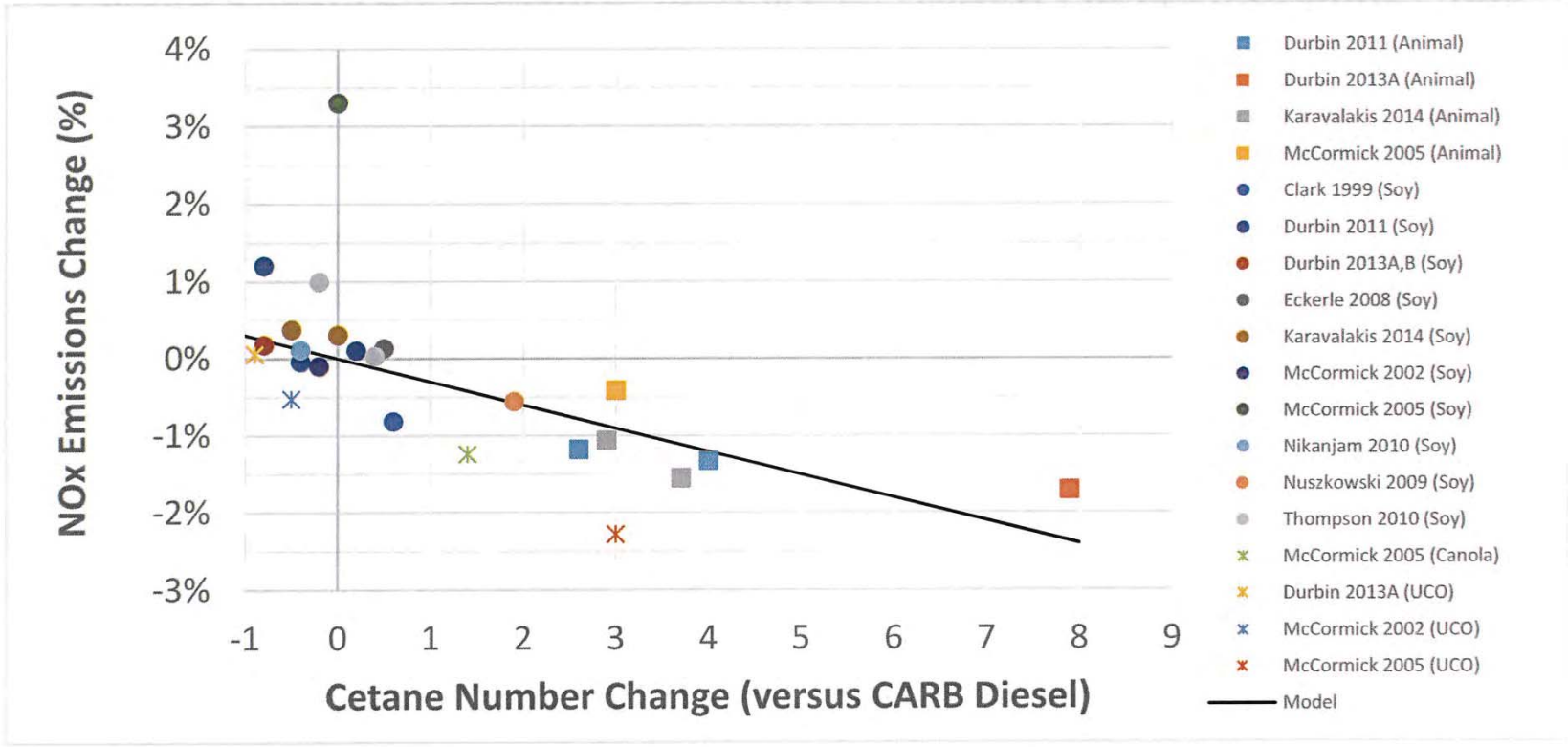
- This approach references the percent change in NOx to the emission intercept $a_i + \sum_{i=2}^{N} \delta_i$ estimated on CARB diesel for each engine/test cycle.
- Average percentage changes for each study, feedstock, engine, test cycle, and blend level are then plotted in the following figure.

There is no detectable difference among feedstock types when NOx emission changes are adjusted to constant Cetane Number



1081

The Response of NOx to Cetane Number is the Same for Soy- and Animal-based Biodiesel Blends (When Adjusted for Blend Level)



1082

Cetane-based Model of Biodiesel NOx Impacts

- Our preliminary analysis suggests a method of predicting the NOx emission impacts of biodiesel blends.
- Further work is needed:
  - To demonstrate that blends mitigated using DTBP or by co-blending with renewable diesel obey the same model
  - To assess whether the four animal feedstocks that have been tested are representative of all animal feedstocks available in the California market.
  - Additional emissions testing may be needed if we see that the four animal feedstocks are not fully representative.
- More advanced statistical techniques (Mixed Effects modeling) may also be needed, as used in the Predictive Model for gasoline.

1083

Some Implications for Biodiesel in California

- Soy- and animal-based blends are not categorically different fuels once their differing effect on blend Cetane is accounted for.
- There is no threshold blend level where biodiesel fuels as a group do not increase NOx, whether soy- or animal-based.
- Soy-based blends clearly and significantly increase NOx by ~1% at B5 and by correspondingly larger amounts at higher blend levels. Soy blends require mitigation at all levels to offset increased NOx emissions.
- Animal-based blends are more complicated. The current research is limited and the evidence is mixed:
  - At least one B5 animal blend significantly increases NOx, while another has been certified as NOx neutral.
  - Other B5 animal blends may or may not increase NOx depending on their effect on Cetane Number (and possibly other factors).
- Animal-based blends cannot be assumed to have no impact on NOx emissions without an assessment of the impact of feedstock blending on Cetane number.

1084

3_B_ADF_GE Responses (Page 473 – 518)

238. Comment: **NOx Emission Impacts of Biodiesel Blends: Technical Summary**

Agency Response:
This document is a presentation of a study conducted by Rincon Ranch. It does not constitute an objection or suggestion on the proposal; however the document was referenced in comments **ADF B3-137** through **ADF B3-152**. The responses to these comments are in the Alternative Diesel Regulation Final Statement of Reasons under comment letter **3_B_ADF_GE**.

ATTACHMENT F

NOx Emission Impacts of Biodiesel Blends

1. Introduction

In the Alternative Diesel Fuels rulemaking, the California Air Resources Board (ARB) is attempting to create a regulatory framework that will permit biodiesel and other alternative diesel fuels to increase their penetration of the California market. Biodiesel is known to increase emissions of nitrogen oxides (NOx). NOx emissions are an important precursor to smog and have historically been subject to stringent emission standards and mitigation programs to prevent growth in emissions over time. A crucial issue with respect to biodiesel is how to "... safeguard against potential increases in oxides of nitrogen (NOx) emissions."[1]

ADF B3-137

In July 2014, ARB released two datasets that represent the fruit of their efforts to compile biodiesel NOx emissions test data available in the literature on heavy-duty truck (HDT) engines. This document and the companion file *"Biodiesel Emissions Analysis Technical Summary 102014.pdf"* present the results of a statistical analysis of the data sets released by ARB that was performed by Rincon Ranch Consulting at the request of Growth Energy.

This analysis focused on whether soy and animal blends will increase NOx at low blend levels. The following issues were examined:

- The NOx impacts of soy and animal blends at B5 and B10;
- The NOx emission differences observed among animal feedstocks and blends;
- For animal blends, the effect on NOx emissions of the Cetane Number (CN) change relative to base fuel that is caused by blending of the animal feedstock; and
- The development of a cetane-based model of the biodiesel NOx impacts of soy and animal blends.

The key results and conclusions of the study are summarized here. For additional information, the reader is directed to *"Biodiesel Emissions Analysis Technicol Summary 102014.pdf"* which has been provided along with this document.

2. Data Used in the Analysis

As noted above, in July 2014, ARB released two datasets of NOx emissions data from testing of biodiesel blends in HDT engines. One file ("B5 & B10 Raw NOx Data") contains the subset of testing for B5 and B10 blends (soy and animal). The test data generated in the four ARB-sponsored UCR studies are present in the form of the individual test run measurements. Because test run information was not reported in their publications, the B5 soy data from Nikanjam 2010 and the B10 soy data from Thompson 2010 are present in the form of emission averages. No animal blends have been tested at the B5 or B10 levels except in the ARB-sponsored emissions testing. A second file ("2014 Biodiesel

ADF B3-138

[1] "Proposed Regulation on the Commercialization of New Alternative Diesel Fuels. Staff Report: Initial Statement of Reason." California Air Resources Board, Stationary Source Division, Alternative Fuels Branch. October 23, 2013. http://www.arb.ca.gov/regact/2013/adf2013/adf2013isor.pdf.

Literature Search Database") contains all of the biodiesel testing available in the literature through the B20 level (soy and animal), including ARB-sponsored testing and the literature search. The data are in the form of emission averages by engine, test cycle, feedstock type, and blend level.

For purposes of this analysis, the following information was added to the ARB datasets:

- The number of test replications for emissions averages for each study (estimated when the source did not report the number);
- The CN for CARB diesel, the biodiesel blends, and the biodiesel feedstocks; and
- Additional NOx emissions testing at the B50 and B100 levels (where available).

Appendix Table A presents a list of the studies included in the dataset and the author references used in citations here.

ADF B3-138 cont.

3. NOx Emissions from Soy Biodiesel Blends

Most past research on biodiesel emissions has focused on soy blends. As a result, the literature is relatively large and diverse. The dataset assembled by ARB is derived from 10 different studies, covers 13 different vegetable feedstocks (10 soy, 2 used cooking oil [UCO], 1 canola), and was conducted using 7 different test cycles on a wide variety of engines in different labs. Most of the data, in terms of number of data points, is derived from the three UCR studies (Durbin 2011, Durbin 2013B, and Karavalakis 2014) sponsored by ARB.

We subjected the soy dataset to a number of different analyses using different statistical techniques and selections of the data to ensure that the conclusions we drew were robust across analytical techniques and datasets. The statistical analysis included the T-Test for the difference in mean values (e.g., between B5 and CARB diesel) and linear regression analysis using several different models. The data subsets were selected to use either individual test runs or emission averages and to contain testing through maximum blend levels of B5, B10, B20, B50, and B100.

ADF B3-139

Our analyses show that there is a consensus among the studies on the NOx impact of soy biodiesel without regard to the specific analytical methods or data used. Soy biodiesel increases NOx emissions by amounts that can be estimated with good statistical confidence because of the large size of the available dataset. The key conclusions are as follows:

- Soy biodiesel increases NOx emissions by ~1% at B5 and ~2% at B10;
- NOx emissions increase in a linear fashion with increasing blend level to reach ~4% at B20 and proportionately larger values at higher blend levels; and
- There is no evidence in the data for a threshold level below which soy biodiesel does not increase NOx.

These conclusions are supported by all of the available studies and data. None of the studies disagree substantially, and while the results for individual blends, engines, and test cycles will vary to some extent, the evidence across a wide range of engines and test cycles is clear. NOx increases can be expected for UCO, canola, and other vegetable biodiesels, but the data are very limited and it is not possible to draw definitive conclusions for these blends.

4. NOx Emissions from Animal Biodiesel Blends

The literature on NOx emissions from animal blends is much smaller. It consists of only four studies, three of which (Durbin 2011, Durbin 2013A, and Karavalakis 2014) were sponsored by ARB. Except for the McCormick 2005 study, the emissions testing was conducted at the UCR CE-CERT lab. A variety of test cycles were used, but most of the testing was conducted on the hot-start FTP cycle. Table 1 presents a summary of the emissions studies for animal biodiesel.

Table 1. Scope of Emissions Testing for Animal Biodiesel

	McCormick 2005	Durbin 2011	Durbin 2013A	Karavalakis 2014
Biodiesel Feedstock	Animal #1	Animal #2	Animal #3	Animal #4
Blend Levels Tested	B20	B5, B20, B50, B100	B5	B5, B10
Engines Tested	2 on-road	3 on-road, 1 off-road	1 on-road	1 on-road
Test Cycles	FTP	FTP, UDDS, 50 mph, ISO 8178	FTP	FTP, SET, UDDS
Test Replications on Biodiesel	6	126	26	80
Is NOx Increase Observed?				
At / Below B10	–	Yes	No	No
Above B10	Yes	Yes	–	–

ADF B3-140

It is important to understand the limitations of this small dataset. Without the ARB-sponsored testing, we would have only the six test replications (individual runs) conducted in the McCormick 2005 study. While the three UCR studies accumulated 232 test replications, the work involved only three different animal feedstocks. Including the McCormick 2005 study, the entire literature on NOx emissions from animal biodiesel is based on only four different animal feedstocks. The small number is an important limitation because animal feedstocks are much less homogenous than soy due the greater variety possible in animal sources and compositions. Further, there are notable differences among the four studies as to whether animal biodiesel increases NOx at the B5 and B10 levels (as indicated by the red circles in the table).

As in the soy analysis, we subjected the animal biodiesel data to a number of different analyses using different statistical techniques and selections of the data to ensure that the conclusions we drew were robust. The T-Test is the most direct method to assess whether NOx emissions are higher at B5 compared to CARB diesel. Using the individual test run data available from the three UCR studies, we find the following for animal biodiesel at the B5 blend level:

- The animal feedstock used in Durbin 2011 increases NOx in 2 of 3 engines. The increase is highly significant[2] statistically for one engine.

[2] The term "significant" is used in this report only to refer to statistical significance. When a result reaches the p=0.05 level, we can be 95 percent confident that it is real. In such case, and at smaller p values, the result is said to be statistically significant. "Significant" has been used by others to indicate that an emissions increase, even if real, is too small to warrant concern. For example, the Predictive Model for RFG will permit alternative gasoline formulations to increase NOx emissions by up to 0.05% and still be classified as emissions compliant. To our

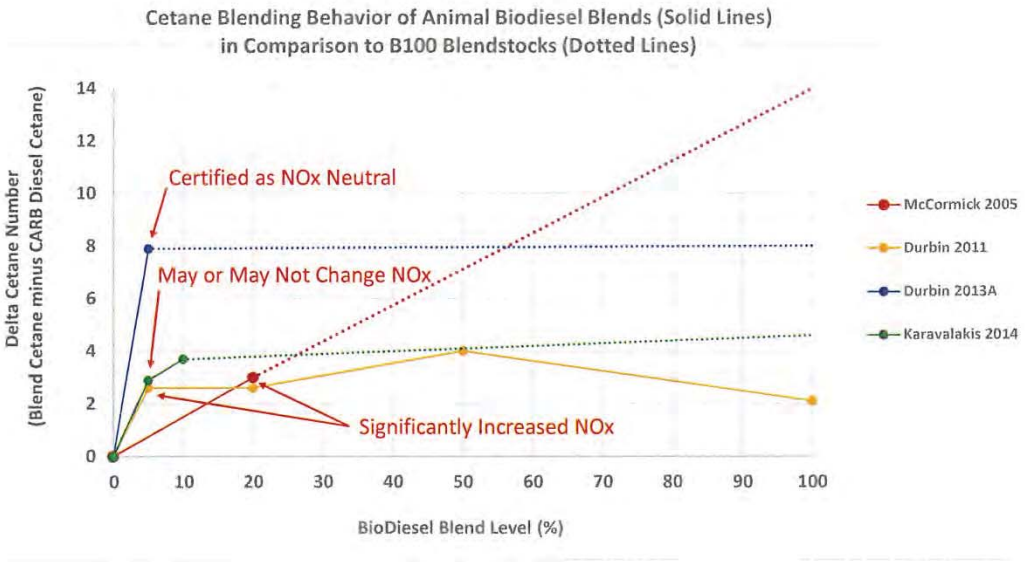
- The animal feedstock used in Durbin 2013A decreases NOx in one engine. The decrease is statistically significant at the p=0.05 level and the blend was certified as NOx neutral at B5.
- The animal feedstock used in Karavalakis 2014 increases NOx in three of six cases and decreases NOx in the other three cases. None of the changes are statistically significant. The blend may or may not change NOx.

ADF B3-140 cont.

Contrary to Staff's assertion that no NOx increase occurs in B5 animal blends, it is clear that some animal blends will significantly increase NOx emissions, while other animal blends will not. The fundamental issue is then understanding what the NOx impact of a particular animal biodiesel blend will be.

The effect of feedstock blending on the CN of the resulting animal blend is the reason for the apparently discordant results among the studies. Figure 1 plots the four series of animal blends in the literature with the blend level on the horizontal axis and the change in blend CN (relative to CARB diesel) on the vertical axis. CN blended linearly to B20 for the McCormick feedstock, which showed a much smaller CN benefit than the feedstocks used by UCR – only three numbers at B20 (0.6 numbers at B5). In contrast, all three UCR animal blends achieve a large CN boost at low blending levels in which most or all of the CN benefit of the feedstock is achieved at B5.

Figure 1. Cetane Blending Behavior of Animal Blends (Solid Lines) Compared to B100 Feedstocks (Dotted Lines)



ADF B3-141

In Durbin 2011, the CNs for the blends are above that of the B100 feedstock. This result is probably caused by lab-to-lab differences (blend CN was determined at CE-CERT, while CN for CARB diesel and the

knowledge, ARB has not formulated a position on the level of NOx increase from alternative diesel fuel that is too small to warrant concern.

B100 feedstock were determined by an outside lab). The actual CN changes are surely lower than shown here – at or below +2 CNs.

The two animal feedstocks that caused statistically significant NOx increases have the smallest CN benefits: McCormick 2005 (red) at B20 and Durbin 2011 (yellow) at B5. The animal B5 blend that passed certification testing as NOx neutral in Durbin 2013A (blue) has the highest CN benefit, where it achieved the entire B100 CN at just 5 percent blending. The Karavalakis 2014 B5 blend (green) had an intermediate CN benefit and may or may not change NOx.

The blending behavior of the UCR blends is surprising in comparison to the McCormick study, and we find relatively little research on the CN blending behavior of animal feedstocks. All conclusions from this dataset will be influenced by the CN blending behavior of the specific animal feedstocks involved. For such conclusions to be reliable, we must be confident that the large CN boost reported for the UCR blends is both real and representative of all animal feedstocks in California. Also, only limited information is available on the sources and characteristics of the animal feedstocks.

ADF B3-141 cont.

To permit all parties to better understand the animal feedstocks that were tested, ARB should release all information that it has on the following:

- CNs (methods of determination and measured values) for the Durbin 2011 and other UCR studies;
- Physical and chemical properties of the animal feedstocks and biodiesel blends tested;
- The distribution of sources, characteristics, and properties in the population of animal feedstocks that are available for use in the California market; and
- How the specific animal feedstocks tested at UCR were selected, including any information that would demonstrate that the feedstock properties and their CN blending behavior are representative of the animal feedstock population available for use in California.

5. Development of a Cetane-based Model of NOx Impacts from Soy and Animal Biodiesel

The results presented above indicate the important role that CN plays in determining the NOx response for animal blends. Animal feedstocks tend to increase the CN of the blend above that of the CARB diesel and the CN change can be large at low blend levels. Soy feedstocks have generally adverse effects and tend to decrease the CN of the blend below that of the CARB diesel; for soy, the CN change at low blend levels can be smaller than the uncertainty in determining CN. The result of our work on a cetane-based model demonstrates that soy and animal blends are not categorically different fuels once their differing effect on CN is accounted for. Their NOx impacts can be represented by the same model as a function of blend level and the change in CN compared to CARB diesel.

ADF B3-142

The document that accompanies this report explains the development of the cetane-based model in some detail. In brief, it was developed using conventional linear regression analysis with log(NOx) emissions as the dependent variable. Intercept terms were included to represent the varying emission levels on CARB diesel for each combination of study, feedstock type, engine, and test cycle. A *b* coefficient was included to represent the change in NOx emissions for each 1 percent biodiesel in a blend at constant CN. A *c* coefficient was included to represent the change in NOx emissions for each 1 number change in CN compared to CARB diesel at constant blend level. Both soy and animal blends

ADF B3-143

were included in the estimation, along with the small number of canola and UCO data points, at blend levels up to (and including) B20.

The model estimation shows that the *b* and *c* coefficients are highly significant statistically ($p < 0.0001$). The estimation results also show the following:

- The *b* coefficient has a value of +0.00156, which estimates that soy and animal biodiesel will increase NOx emissions by 0.16% for each 1 percent biodiesel at constant CN or by 0.8% at B5.
- The *c* coefficient estimates that +5 CNs will decrease NOx emissions by 1.5 percent at constant blend level. This result is completely consistent with earlier work[3] on the relationship between CN and NOx emissions in HDT engines, which also found that +5 CNs will decrease NOx emissions by 1.5 percent in base fuels with CN ~50.
- An increase of -b/c = 0.5 CNs is needed to offset the NOx increase expected from each 1% biodiesel added. For B5, an increase of 2.5 CNs is required to offset the expected NOx increase.

The results explain why soy and animal blends appear to be different fuels. Soy blends have an additional, adverse CN effect that increases their NOx impact to ~1% at B5. Animal blends will generally increase CN and that reduces their NOx impact to about one-half the soy level or less depending on the CN change caused by blending. The results also explain why some animal blends do not increase NOx emissions. If an animal feedstock increases CN by more than ~0.5 numbers for each 1% biodiesel blended, then the resulting fuel may not increase NOx emissions.

ADF B3-143 cont.

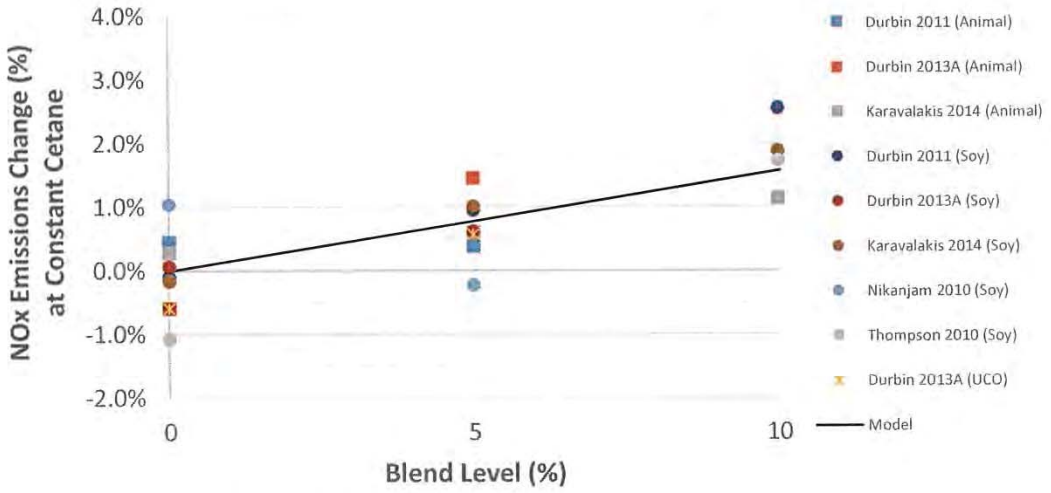
To demonstrate these conclusions, Figure 2 presents NOx emissions as a function of blend level for all fuels used to estimate the model once NOx emissions are adjusted for the CN change observed for each blend (animal blends are plotted as squares, soy blends as circles, and the non-soy vegetable blends as asterisks). For example, if an animal blend increased CN, then its NOx impact is increased as we return it to the base fuel CN. If a soy blend decreases CN, then its NOx impact is decreased as we return it to the base fuel CN. Once adjusted, percent changes in emissions are calculated. As seen in the figure, there is no discernable difference among feedstock types once CN changes are taken into account. Animal and soy blends scatter on both sides of the regression line, indicating that they obey the same blend level model.

Note the scatter of points around the regression line (which gives the "average" response). Some of the scatter is due simply to emissions measurement error. But other factors may be involved in determining the NOx impact for a given feedstock, including differences in the FAME composition and uncertainty in determining CN for the blends. If ARB were to adopt a predictive model to determine the CN improvement needed to mitigate NOx, it should use the model to evaluate a "worst case" feedstock, meaning a point near the upper end of the range at each blend level.

The most important conclusion of this work is that soy and animal biodiesel blends are not categorically different fuels. Their emissions effects are similar, but they show different NOx impacts because they have different effects on CN. Further, this work provides a potential answer to the problem that some animal blends will significantly increase NOx emissions, while other blends will not, by indicating what individual blends may do.

[3] *The Effect of Cetane Number Increase Due to Additives on NOx Emissions from Heavy-Duty Highway Engines.* EPA420-R-03-002. February 2004. Figure IV.A-1.

Figure 2. There Are No Detectable Differences Among Feedstock Types Once NOx Emissions Are Adjusted to Constant CN



Note: Animal blends are plotted as squares, soy blends as circles, and the non-soy vegetable blends as asterisks.

6. Summary and Conclusions

Based on the results summarized above, ARB must consider as part of the current rulemaking a regulatory structure in which the NOx impacts of soy and animal biodiesel are accounted for using a statistical model analogous to the Predictive Model for RFG. We see the cetane-based model presented here as a possible draft for a biodiesel predictive model, but further work is needed to:

- Demonstrate that blends mitigated using DTBP obey the same model; and
- Assess whether the four animal feedstocks that have been tested are representative of all animal feedstocks available in the California market.

ADF B3-144

Additional emissions testing may be needed if it is determined that the four animal feedstocks that have been tested are not representative of the population of animal feedstocks available for use in the California market.

ADF B3-145

Further, more advanced statistical techniques should be used as was done in developing the Predictive Model for California Reformulated gasoline. The dataset used here is highly unbalanced, meaning that there are varying numbers of data points for each combination of study, feedstock type, engine, and test cycle. In fact, only a fraction of all possible study/feedstock/engine/test cycle cells are represented by one or more data points. A technique known as Mixed Effects Modeling is appropriate in such cases and its use will assure that coefficient estimates are not biased by the unbalanced distribution of the data.

ADF B3-146

The key conclusions of this study are summarized below.

- Soy and animal blends are not categorically different fuels once their differing effects on blend CN are taken into account. ADF B3-147
- There is no evidence in the data of a threshold level below which biodiesel fuels as a group do not increase NOx, whether soy or animal. However, individual blends may not increase NOx if the CN gain caused by blending is sufficiently large to offset the underlying tendency of all biodiesel blends to increase NOx emissions. ADF B3-148
- Soy blends clearly and significantly increase NOx by ~1% at B5 and by proportionately larger amounts at higher blend levels. Soy blends require mitigation at all levels to offset increased NOx emissions. ADF B3-149
- Animal blends are more complicated. The current research is limited and the evidence is mixed. At least one B5 animal blend significantly increased NOx, while another has been certified as NOx neutral. Other B5 animal blends may or may not increase NOx depending on their effect on CN (and possibly other factors). ADF B3-150
- Staff's assertion that no NOx increase occurs at B5 in animal blends is incorrect. Some animal blends will significantly increase NOx emissions, while other animal blends will not. ADF B3-151
- Animal blends cannot be assumed to have no impact on NOx emissions without a determination of the impact of feedstock blending on CN. ADF B3-152

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APPENDIX TABLE A: REFERENCES TO LITERATURE

Author	Title	Feedstocks Studied	Blends Studied
Clark 1999	Transient Emissions Comparisons of Alternative Compression Ignition Fuel	Soy	B20
McCormick 2002	Fuel Additive and Blending Approaches to Reducing NOx Emissions from Biodiesel	Soy, UCO	B20
McCormick 2005	Regulated Emissions from Biodiesel Tested in Heavy-Duty Engines Meeting 2004 Emissions	Soy, Canola, Animal	B20
Eckerle 2008	Effects of Methyl Ester Biodiesel Blends on NOx Emissions	Soy	B20
Nuszkowski 2009	Evaluation of the NOx emissions from heavy duty diesel engines with the addition of cetane improvers.	Soy	B20
Nikanjam 2010	Performance and emissions of diesel and alternative diesel fuels	Soy	B5, B20
Thompson 2010	Neat fuel influence on biodiesel blend emissions	Soy	B10, B20
Durbin 2011	Biodiesel Characterization and NOx Mitigation Study	Soy, Animal	B5, B10, B20
Durbin 2013A	CARB B5 Preliminary and Certification Testing	Animal	B5
Durbin 2013B	CARB B20 Biodiesel Preliminary and Certification Testing	Soy, UCO	B20
Karavalakis 2014	CARB Comprehensive B5/B10 Biodiesel Blends Heavy-Duty Engine Dynamometer Testing	Soy, Animal	B5, B10

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3_B_ADF_GE Responses (Page 519 – 528)

239. Comment**: ADF B3-137 and ADF B3-138**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

240. Comment: **ADF B3-139**
The comment states that soy-based biodiesel increases NOx emissions by amounts that can be estimated with good statistical significance.

Agency Response: Please see response **ADF 8-1**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

241. Comment: **ADF B3-140**
The comment states that some animal-based biodiesel blends will significantly increase NOx emissions while other animal-based blends will not.

Agency Response: Please see response **ADF 8-1**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

242. Comment: **ADF B3-141**
The comment states that all data on animal feedstock tests should be released to the public.

Agency Response: Please see response **ADF 5-3**."

To the extent that further information will clarify the commenter's concern, studies used by ARB staff that included cetane information were referenced in the ADF Staff Report. Staff made no attempt to procure animal and soy feedstocks with specific properties, but endeavored to procure biodiesel that was commercially available and met the required ASTM standards in order to be representative of biodiesel in California.

The proposed ADF Regulation is designed to reduce, over time, the NO_X emissions from biodiesel. The analysis that staff performed to arrive at the conclusion that NO_X emissions would decrease over time, including assumptions, technical review, and data selection, is described in detail in the ADF staff report, especially in Chapter 7 and Appendix B. That analysis was conducted using the best available data to evaluate the impacts of the ADF Regulation. Additionally,

staff's analysis was completed in consultation with stakeholders and industry experts. An independent reviewer examined the data and methods that staff utilized; his conclusions are set out in Appendix G of the ADF staff report.

For information on technical review, and data selection please see discussion of statistical analysis in **ADF 8-1**, and NOx emissions under the ADF proposal in **ADF 17-7**. Each of these responses can be found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

243. Comment: **ADF B3-142**
The comment argues for the use of an emissions predictive model correlating several fuel properties, including cetane number, to NOx emissions for a fuel rather than the current methods used in the ADF proposal.

Agency Response:
1. ARB staff agrees that cetane number (CN) of a fuel is a strong indicator of its NOx emissions. Based on the studies staff reviewed, which included primarily testing on soy and animal feedstocks, the feedstocks could generally be categorized as either low or high saturation based on differences in their cetane number. Low saturation biodiesel, such as soy based biodiesel exhibited a natural CN at or below 56. High saturation biodiesel, such as animal biodiesel, exhibited a natural CN of 56 or above. Therefore staff proposed a CN cutoff of 56 for different provisions for NOx control levels. Staff also proposed to vary the requirements based on seasonal variation as well. In the period between November 1 and March 31, NOx control is less necessary due to reduced ozone exceedances; however, during this same period PM controls are especially important. In order to maximize the PM reductions from biodiesel and allow increased flexibility for the biodiesel industry the regulation provides for a higher NOx control level during this period.

Biodiesel certification provisions allow any ADF blend up to B20 that is proven to achieve CARB diesel emissions equivalency to be certified upon approval, regardless of CN.

2. ARB staff considered the use of a predictive model for the effects of biodiesel, and concluded that the simpler approach of determining feedstock emissions effects based on variation in cetane number, rather than using multiple properties, was warranted since cetane number was found to be the primary property effecting NOx emissions.

244. Comment: **ADF B3-143**
The comment outlines the development of a cetane-based model contends that an emissions predictive model is preferable for determining NOx emissions for a fuel.

Agency Response:
Please see the discussion of the emissions predictive model in response **ADF B3-142**.

245. Comment: **ADF B3-144**
The comment contends that an emissions predictive model is preferable for determining NOx emissions for a fuel.

Agency Response:
Please see the discussion of the emissions predictive model in response **ADF B3-142**.

246. Comment: **ADF B3-145**
The comment suggests additional testing may be needed for the animal feedstocks which are deemed non-representative.

Agency Response:
Please see response **ADF 8-1**, found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations," and responses **ADF B3-141** and **ADF B3-142**, found in this document.

247. Comment: **ADF B3-146**
The comment suggests the use of advanced statistics are appropriate for determining NOx emissions for a fuel rather than the current methods used in the ADF proposal.

Agency Response:
ARB's statistical analysis used the mixed effects modeling referenced by the commenter. For more information please see response **ADF B3-74**, found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations." This comment contains a reference to **ADF 17-3**.

248. Comment: **ADF B3-147**
The comment states that soy and animal blends are not categorically different once their differing effect on blend CN are taken into account.

Agency Response: Please see response **ADF B3-142**.

249. Comment: **ADF B3-148**
The comment states that individual blends will not increase NOx if the CN gain caused by blending is sufficiently large.

Agency Response: Please see response **ADF B3-142**.

250. Comment: **ADF B3-149**
The comment states that soy blends should require mitigation at all levels to offset increased NOx emissions.

Agency Response:
Please see the discussion of statistical approach found in response **ADF 8-1**, which can be found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

Additionally, the ADF regulation accounts for offsetting factors to determine the NOx control level. Emissions are offset through either offsetting factors or in-use requirements at all soy blend levels in the current proposal.

251. Comment: **ADF B3-150**
The comment states that the effect of animal blends on NOx emissions is inconsistent.

Agency Response:
Please see discussion of NOx increase at lower blends in response **ADF 8-1**, which can be found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations," and **ADF B3-142**, regarding cetane number..

252. Comment: **ADF B3-151**
The comment states that the effect of animal blends on NOx emissions is inconsistent.

Agency Response:
Please see discussion of NOx increase at lower blends in response **ADF 8-1**, which can be found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations,"**,** and **ADF B3-142**, regarding cetane number.

253. Comment: **ADF B3-152**
The comment states that animal blends cannot be assumed to have no impact on NOx emissions.

Agency Response:
Please see discussion of NOx increase at lower blends in response **ADF 8-1**, which can be found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations,"**,** and **ADF B3-142**, regarding cetane number.

DELIVERED BY HAND

February 18, 2015

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Tracy Jensen
Clerk of the Board
California Air Resources Board
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RE: "Comments on the LCFS and ADF rulemaking proposals."

Dear Clerk of the Board:

I have discovered that one attachment to my Declaration included in electronic filing for Growth Energy that Josh Wilter of my staff made yesterday was not included in the upload. I am enclosing the attachment here and am emailing it to Jim Aquila and Lex Mitchel who are listed as the staff contacts for this item in the Hearing Notice. The contents of this attachment do not differ from the content of my Declaration, and the bulk of the analysis in the attachment was provided to the ARB staff on October 24, 2014 as workshop comments.

Sincerely,

Jim Lyons
Senior Partner

Attachments:

NOx EMISSIONS IMPACTS OF BIODIESEL BLENDS

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February 10, 2015

NOx EMISSIONS IMPACTS OF BIODIESEL BLENDS

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NOx EMISSION IMPACTS OF BIODIESEL BLENDS

1. EXECUTIVE SUMMARY

The purpose of the Alternative Diesel Fuels (ADF) rulemaking, according to the Air Resources Board (ARB), is to create a regulatory framework that will permit biodiesel and other low-carbon, alternative diesel fuels to "enter the commercial market in California, while mitigating any potential environmental or public health impacts." [1]

The work presented in this report assesses the impacts of biodiesel use on NOx emissions from conventional and new technology diesel engines. It was performed by Rincon Ranch Consulting under subcontract to Sierra Research at the request of Growth Energy.

At present, most diesel fuel and biodiesel is consumed in conventional diesel engines that do not have exhaust gas after-treatment to reduce NOx emissions. The consensus of the literature is that biodiesel will increase NOx emissions by amounts that depend on the blending percentage (how much biodiesel is present in the diesel fuel) and the type of biodiesel feedstock (soy versus animal sources). NOx increases of 1-2% are expected from soy biodiesel at blend levels of B5 to B10 with smaller increases expected, in general, from animal biodiesel at the B5 to B10 level. ADF B3-153

Over time, new technology diesel engines (NTDEs) equipped with exhaust gas after-treatment controls for NOx will increasingly make up the heavy duty fleet in response to other ARB programs. While baseline emissions from these engines will be reduced compared to conventional engines, the consensus of the literature available today is that use of biodiesel will still increase NOx emissions above the reduced baseline. At the B20 level, the NOx increase appears to be greater on a percentage basis than would be expected in conventional diesel engines. ADF B3-154

The results of this work indicate the following with respect to conventional diesel engines:

- Soy biodiesels will increase NOx emissions at the B5 and B10 levels by approximately 1% and 2%, respectively. This work and Staff's analysis concur in both the conclusion and the estimated levels of NOx increase at B5 and B10. Soy biodiesels in this blend range require NOx mitigation on a per-gallon basis in order to prevent increases in NOx emissions. ADF B3-155
- The consensus of the research community is that the effect of soy biodiesel on NOx emissions is continuous and linear with respect to the blending percentage. NOx ADF B3-156

[1] "Proposed Regulation on the Commercialization of New Alternative Diesel Fuels. Staff Report: Initial Statement of Reason." California Air Resources Board, Stationary Source Division, Alternative Fuels Branch. January 2, 2015. http://www.arb.ca.gov/regact/2015/adf2015/adf15isor.pdf. Page 11.

increases have been observed at levels as low as B1.[2] The statistical analysis performed for ARB by Rocke supports this conclusion and estimates that soy biodiesel will increase NOx emissions by about 0.2% for each 1% biodiesel in the blend (0.99% for each 5% biodiesel). ADF B3-156 cont.

In spite of this consensus, the Staff proposal requires NOx mitigation for soy-based biodiesel only above the B5 level in summer months and above the B10 level in winter months. Soy biodiesel blended at the B5 and lower levels would not require mitigation in any circumstance. The ADF regulatory framework must require mitigation of soy-based biodiesels at all blend levels if it is to ensure that such fuels do not increase NOx emissions. ADF B3-157

- The effect of animal-based biodiesel on NOx emissions is more complicated than for soy-based blends. As the available literature demonstrates, some animal-based biodiesels will increase NOx emissions while other animal biodiesels will not. While Staff's proposal would establish B10 as the control level for animal-based biodiesel (e.g., mitigation would be required year-round for blends above B10), the available data do not support Staff's conclusion that there will not be increases in NOx emissions from B10 and lower blends. Given the Staff proposal, the only way to ensure that animal-based biodiesel does not increase NOx emissions is to require mitigation at all blend levels. ADF B3-158

- Staff presents information indicating that animal biodiesels decrease NOx by 0.2% on average and that the emissions change in comparison to CARB diesel fuel is not statistically significant. The average and the test for statistical significance are both flawed by the failure to consider the varying effects that animal feedstocks have on Cetane Number (CN). The absence of CN as a variable in Staff's analysis leads Staff to wrongly conclude that animal biodiesels will not increase NOx below the B10 level. ADF B3-159

- It is well established that increasing CN will reduce NOx emissions from diesel engines. Whether an animal biodiesel will increase NOx depends primarily on the extent to which the feedstock blending increases the CN of the blended fuel. Soy and animal biodiesel blends are not categorically different fuels once the differing effect of soy- and animal-feedstocks on CN is taken into account. ADF B3-160

With respect to new technology diesel engines (NTDEs):

- Staff is incorrect in concluding that biodiesel use will not increase NOx in NTDEs. This conclusion is based on a highly selective reading of the technical literature (choosing one of four available studies) and relies on the one study in which the laboratory was not well equipped to measure the low levels of tailpipe NOx emissions from NTDEs. ADF B3-161

- A fair reading of the technical literature indicates that B20 biodiesel will increase NOx emissions by about 20% in NTDEs. The four best studies estimate that B20 biodiesel ADF B3-162

[2] McCormick 2002 tested a Fisher-Tropsch (FT) base fuel blended at the B1, B20, and B80 levels. Although the very high FT cetane number (≥75) takes it out of the range of commercial diesel fuels, the study nevertheless measured higher NOx emissions at the B1 level than it did on the FT base fuel.

increases NOx by 18-22% in NTDEs and that the increase is statistically significant. This is a greater percentage NOx increase in proportion to blend level than the increase caused by soy biodiesel in conventional diesel engines (1% at B5, 2% at B10 and ~4% at B20).

ADF B3-162 cont.

- The technical literature also indicates that one should expect NOx emissions to increase at blend levels below B20, with the size of the NOx increase being proportionate to blend level. At the B5 level, NOx emissions from NTDEs are expected to increase by about 5%.

ADF B3-163

- Staff makes no mention of the concern that use of biodiesel fuels in NTDEs may lead to the loss of NOx conversion efficiency in urea-SCR systems by shifting the NO_2/NOx ratio to lower values. Staff's proposal to allow B20 biodiesel to be used in NTDEs without mitigation potentially places at risk the investment in NOx after-treatment systems to meet the stringent NOx certification levels now in effect.

ADF B3-164

This analysis demonstrates that the proposed regulations will not "ensure that the use of biodiesel due to LCFS will not result in increases in NOx emissions in California." In fact, the regulations will result in increased NOx emissions in California from the following:

- B5 and lower soy biodiesels year round;
- B6 to B10 soy biodiesels in winter;
- At least some B10 and lower animal biodiesels year-round; and
- B20 and lower biodiesels of all types in NTDEs.

ADF B3-165

To our knowledge, ARB has not formulated a position on the level of NOx increase from alternative diesel fuel that is too small to warrant concern. A point of comparison for the NOx increases permitted by the proposed ADF regulations is the ARB program for Reformulated Gasoline (RFG). The RFG program permits alternative gasoline formulations to be sold in the California market provided they are demonstrated to be emissions equivalent to a reference gasoline using the Predictive Model for RFG. The emissions analysis differs somewhat for winter and summer gasoline, but in no instance may the alternative formulation increase emissions of the pollutants considered by more than 0.05%.

ADF B3-166

The biodiesel NOx emission increases permitted under the proposed ADF regulations dwarf the 0.05% threshold applied to RFG. Soy biodiesel will increase NOx by more than 0.05% at blend levels above 0.25% biodiesel (B0.25). Some animal biodiesels will increase NOx by 0.05% or more at blend levels twice as high (B0.5). The NOx emissions increase in NTDEs appears to be substantially greater on a percentage basis, so that biodiesels will exceed the 0.05% threshold at much lower blend levels.

ADF B3-167

In the ISOR, Staff uses the term "low saturation" to refer to soy and other feedstocks with CN < 56 and "high saturation" to refer to feedstocks, including animal sources, with CN ≥ 56. Classification based on saturation is useful because of its association with CN. By itself, however, it does not alleviate the concerns regarding NOx increases from unmitigated fuels.

ADF B3-168

The analysis presented here indicates that CN changes induced by biodiesel blending have a large influence on the size of the NOx increase that is observed. Soy (low saturation) biodiesels adversely affect CN leading to larger NOx increases; animal (high saturation) biodiesels increase CN leading to smaller NOx increases. In fact, soy and animal biodiesels are not categorically different fuels once their differing effect on blend CN is taken into account.

ADF B3-169

It is strongly recommended that ARB consider as part of the ADF rulemaking a regulatory structure in which the NOx impacts of soy and animal biodiesel are accounted for using a statistical model analogous to the Predictive Model for RFG. The analysis documented in this report provides a possible form for a biodiesel predictive model.

ADF B3-170

2. NOX EMISSIONS FROM CONVENTIONAL DIESEL ENGINES

2.1 ARB Analysis in Support of the Proposed Regulations

In support of the proposed regulations, ARB commissioned an analysis of the available NOx emissions data by David M. Rocke, PhD. The results of the analysis are reported in Appendix G: Supplemental Statistical Analysis[3] to the ISOR. The analysis used NOx emission measurements on ULSD, B5, and B10 fuels in conventional diesel engines from five studies. The dataset is substantially the same as that used by Rincon Ranch Consulting in the analysis presented later in this section.

The Rocke analysis formulated a series of statistical models involving log(NOx) as the dependent variable and used a statistical approach termed Mixed Effects modeling to estimate the coefficient values. The Mixed Effects approach has statistical advantages over more commonly used methods when dealing with unbalanced datasets, as is the case here. A number of different models were specified, estimated, and the results compared in order to ensure that conclusions drawn from the analysis do not depend upon the model specifications.

ADF B3-171

For soy-based biodiesel, the Rocke study concludes that soy fuels increase NOx by 1% at B5 and by 2% at B10. The study also demonstrated that the NOx increase is linearly related to the blend level. The slope was estimated to be 0.99% for each 5% biodiesel in a blend and was highly significant statistically ($p << 0.001$). These results agree with the Rincon Ranch analysis presented later in this report. There is no controversy with regard to the NOx impact of soy-based biodiesel. Soy biodiesel will increase NOx emissions at all blend levels by about 0.2% for each 1% biodiesel in the blend.

With respect to animal biodiesel, the Rocke study concludes that animal biodiesel does not increase NOx emissions at B5 or B10. The emission changes that are observed are not statistically significant. There is controversy here because the Rocke analysis did not account for the effect of feedstock blending on the CN of the tested fuels. The CN change compared to ULSD is a fixed effect that must be accounted for because the four animal feedstocks that have been used in the technical literature show substantially different cetane behavior in blending.

ADF B3-172

[3] http://www.arb.ca.gov/regact/2015/adf2015/adf15appg.pdf.

The case for cetane as an explanatory variable for NOx emissions in animal blends is made in Section 2.2.4 of this report. It is well established that increasing CN will reduce NOx emissions from diesel engines. For example, ARB has shown that the additive DTBP can be used to raise CN and mitigate NOx increases caused by biodiesel blending. Whether an animal biodiesel will increase NOx depends primarily on the extent to which the feedstock blending increases CN of the blended fuel. The two animal blends that showed the smallest CN gain over ULSD caused statistically significant NOx increases in the engines tested. The one animal blend that showed the largest CN gain was certified to be NOx neutral, while the animal blend with the next largest CN gain may or may not be NOx neutral. Cetane appears to blend linearly when using soy feedstocks, so that the CN gain over ULSD is highly correlated with blend level. The same is not true for animal feedstocks, where highly non-linear blending behavior has been observed.

The Rocke analysis used a Mixed Effects model to estimate the NOx emissions change at B5 and B10. For animal blends, it concluded that the observed emission changes are not statistically significant. Implicit in the approach is the assumption that the fuels being tested are different, individual realizations from a homogenous population. In this instance, the residual variation not accounted for by the blend level is a random effect representing the scatter in test results due to a variety of factors. The statistical significance of the blend level effect (a fixed effect) is judged in comparison to the residual variation. When the residual variation is large in comparison to the fixed effect, the latter is said to be not statistically significant.

ADF B3-172 cont.

The assumption of a homogenous population is appropriate for soy-based biodiesels. One soybean is much like the next, and the only appreciable differences among soy fuels will result from the methods of preparation. However, the assumption of homogeneity is not appropriate for animal-based biodiesels, which can be drawn from a variety of animal sources and prepared in different ways. The non-homogeneity is seen most readily in the greatly different cetane responses of biodiesel fuels:

- In the McCormick 2005 and Durbin 2011 studies, the animal feedstocks increased the CN of the biodiesel blends by small amounts. These fuels led to statistically significant increases in NOx.
- In the Durbin 2013A study, blending at the B5 level was sufficient to raise the CN of the blend by 8 numbers to reach the cetane level of the feedstock itself. This fuel was certified as NOx neutral at B5.
- The animal feedstock used in the Karavalakis 2014 study was intermediate in its CN effect and also intermediate in its NOx effect.

Because the ARB and Rocke studies have not included cetane as an explanatory variable for animal-based biodiesels, the residual variation term has been enlarged since a portion of it could be accounted for by including a fixed-effects term for cetane. With an enlarged estimate of the residual variance, the studies more easily find that the fixed effect of blend level is not statistically significant.

The absence of cetane as an explanatory variable also affects other methods of analysis used by Rocke. In a t-test comparison of emission differences between biodiesel and ULSD, Rocke finds two cases in which animal B5 changes NOx by statistically significant amounts (one increasing NOx and the other decreasing NOx) and one such case in animal B10 (decreasing NOx), while the other cases show no statistically significant change compared to the base fuel. The study wrongly concludes that these results demonstrate no or little systematic evidence for B5 or B10 animal to increase NOx emissions. In fact, these cases are systematically related to the CN gain of the animal blends in comparison to the base fuel.

ADF B3-172 cont.

The Rocke analysis was well planned and executed, and we concur with the conclusions drawn for soy-based blends. Because the analysis for animal-based blends is flawed by omission of a cetane variable, it should be revised to address CN gain. We expect that a revised analysis will shed further light on the circumstances in which animal-based biodiesels will and will not increase NOx emissions.

2.2 Rincon Ranch Analysis of ARB NOx Emissions Data

In July 2014, ARB released two datasets that represent the fruit of its efforts to compile the available biodiesel NOx emissions test data on conventional heavy-duty truck (HDT) engines. This report and the companion file *"Biodiesel Emissions Analysis Technical Summary 102014.pdf,"* which is attached to and incorporated in this report, present the results of a statistical analysis of the data sets released by ARB that was performed by Rincon Ranch Consulting at the request of Growth Energy.

The analysis presented below focused on whether soy and animal blends will increase NOx at low blend levels in conventional diesel engines. The following issues were examined:

- The NOx impacts of soy and animal blends at B5 and B10;
- The NOx emission differences observed among animal feedstocks and blends;
- For animal blends, the effect on NOx emissions of the CN change relative to base fuel that is caused by blending of the animal feedstock; and
- The development of a cetane-based model of the biodiesel NOx impacts of soy and animal blends.

2.2.1 Data Used in the Analysis

As noted above, in July 2014, ARB released two datasets of NOx emissions data from testing of biodiesel blends in HDT engines. One file ("B5 & B10 Raw NOx Data") contains the subset of testing for B5 and B10 blends (soy and animal). The test data generated in the four ARB-sponsored UCR studies are present in the form of the individual test run measurements. Because test run information was not reported in their publications, the B5 soy data from Nikanjam 2010 and the B10 soy data from Thompson 2010 are present in the form of emission averages. No animal blends have been tested at the B5 or B10 levels except in the ARB-sponsored emissions testing. A second file ("2014 Biodiesel Literature Search Database") contains all of the biodiesel

ADF B3-173

testing available in the literature through the B20 level (soy and animal), including ARB-sponsored testing and the literature search. The data are in the form of emission averages by engine, test cycle, feedstock type, and blend level.

For purposes of this analysis, the following information was added to the ARB datasets:

- The number of test replications for emissions averages for each study (estimated when the source did not report the number);
- The CN for CARB diesel, the biodiesel blends, and the biodiesel feedstocks; and
- Additional NOx emissions testing at the B50 and B100 levels (where available).

Appendix Table A presents a list of the studies included in the dataset and the author references used in citations here.

ADF B3-173 cont.

2.2.2 NOx Emissions from Soy Biodiesel Blends

Most past research on biodiesel emissions has focused on soy blends. As a result, the literature is relatively large and diverse. The dataset assembled by ARB is derived from 10 different studies, covers 13 different vegetable feedstocks (10 soy, 2 used cooking oil [UCO], 1 canola), and was conducted using 7 different test cycles on a wide variety of engines in different labs. Most of the data, in terms of number of data points, are derived from the three UCR studies (Durbin 2011, Durbin 2013B, and Karavalakis 2014) sponsored by ARB.

We subjected the soy dataset to a number of different analyses using different statistical techniques and selections of the data to ensure that the conclusions we drew were robust. The statistical analyses included the t-test for the difference in mean values (e.g., between B5 and CARB diesel) and linear regression analysis using several different models. The data subsets were selected to use either individual test runs or emission averages and to contain testing through maximum blend levels of B5, B10, B20, B50, and B100.

ADF B3-174

Our analyses show that there is a consensus among the studies on the NOx impact of soy biodiesel without regard to the specific analytical methods or data used. Soy biodiesel increases NOx emissions by amounts that can be estimated with good statistical confidence because of the large size of the available dataset. The key conclusions are as follows:

- Soy biodiesel increases NOx emissions by ~1% at B5 and ~2% at B10;
- NOx emissions increase in a linear fashion with increasing blend level to reach ~4% at B20 and proportionately larger values at higher blend levels; and
- There is no evidence in the data for a threshold level below which soy biodiesel does not increase NOx.

These conclusions are supported by all of the available studies and data. None of the studies disagree substantially, and while the results for individual blends, engines, and test cycles will vary to some extent, the evidence across a wide range of engines and test cycles is clear. NOx

increases can be expected for UCO, canola, and other vegetable biodiesels, but the data are very limited and it is not possible to draw definitive conclusions for these blends.

ADF B3-174 cont.

2.2.3 NOx Emissions from Animal Biodiesel Blends

The literature on NOx emissions from animal blends is much smaller—it consists of only four studies, three of which (Durbin 2011, Durbin 2013A, and Karavalakis 2014) were sponsored by ARB. Except for the McCormick 2005 study, the emissions testing was conducted at the UCR CE-CERT lab. A variety of test cycles were used, but most of the testing was conducted on the hot-start FTP cycle. Table 1 presents a summary of the emissions studies for animal biodiesel.

Table 1. Scope of Emissions Testing for Animal Biodiesel

	McCormick 2005	Durbin 2011	Durbin 2013A	Karavalakis 2014
Biodiesel Feedstock	Animal #1	Animal #2	Animal #3	Animal #4
Blend Levels Tested	B20	B5, B20, B50, B100	B5	B5, B10
Engines Tested	2 on-road	3 on-road, 1 off-road	1 on-road	1 on-road
Test Cycles	FTP	FTP, UDDS, 50 mph, ISO 8178	FTP	FTP, SET, UDDS
Test Replications on Biodiesel	6	126	26	80
Is NOx Increase Observed?				
At / Below B10	–	Yes	No	No
Above B10	Yes	Yes	–	–

ADF B3-175

It is important to understand the limitations of this small dataset. Without the ARB-sponsored testing, we would have only the six test replications (individual runs) conducted in the McCormick 2005 study. While the three UCR studies accumulated 232 test replications, the work involved only three different animal feedstocks. Including the McCormick 2005 study, the entire literature on NOx emissions from animal biodiesel is based on only four different animal feedstocks. The small number is an important limitation because animal feedstocks are much less homogenous than soy due the greater variety possible in animal sources and compositions. Further, there are notable differences among the four studies as to whether animal biodiesel increases NOx at the B5 and B10 levels (as indicated by the red circles in the table).

As in the soy analysis, we subjected the animal biodiesel data to a number of different analyses using different statistical techniques and selections of the data to ensure that the conclusions we drew were robust. The t-test is the most direct method to assess whether NOx emissions are higher at B5 compared to CARB diesel. Using the individual test run data available from the three UCR studies, we find the following for animal biodiesel at the B5 blend level:

- The animal feedstock used in Durbin 2011 increases NOx in 2 of 3 engines. The increase is highly significant[4] statistically for one engine.

- The animal feedstock used in Durbin 2013A decreases NOx in one engine. The decrease is statistically significant at the p=0.05 level, and the blend was certified as NOx neutral at B5.

- The animal feedstock used in Karavalakis 2014 increases NOx in three of six cases and decreases NOx in the other three cases. None of the changes are statistically significant. The blend may or may not change NOx.

ADF B3-175 cont.

Contrary to Staff's assertion that no NOx increase occurs in B5 animal blends, it is clear that some animal blends will significantly increase NOx emissions, while other animal blends will not. The fundamental issue is then understanding what the NOx impact of a particular animal biodiesel blend will be.

The effect of feedstock blending on the CN of the resulting animal blend is the reason for the apparently discordant results among the studies. Figure 1 plots the four series of animal blends used in the studies, with blend level on the horizontal axis and the change in blend CN (relative to CARB diesel) on the vertical axis. CN blended linearly to B20 for the McCormick feedstock, which showed a much smaller CN benefit than the feedstocks used by UCR—only three numbers at B20 (0.6 numbers at B5). In contrast, all three UCR animal blends achieve a large CN boost at low blending levels in which most or all of the CN benefit of the feedstock is achieved at B5.

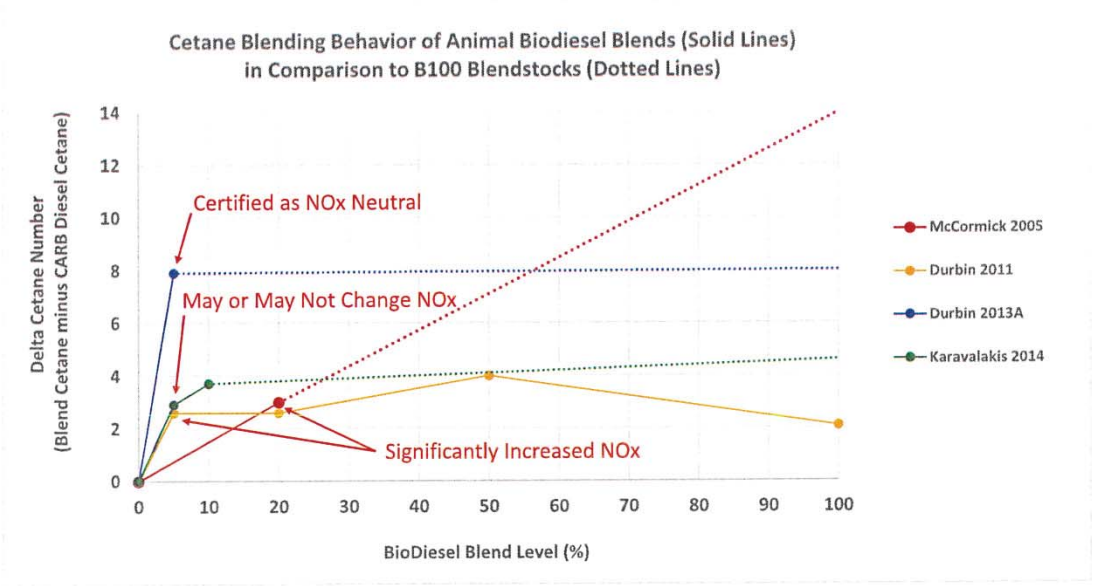
In Durbin 2011, the CNs for the blends are above that of the B100 feedstock. This result is probably caused by lab-to-lab differences (blend CN was determined at CE-CERT, while CN for CARB diesel and the B100 feedstock were determined by an outside lab). The actual CN changes are surely lower than shown here—at or below +2 CNs.

ADF B3-176

The two animal feedstocks that caused statistically significant NOx increases have the smallest CN benefits: McCormick 2005 (red) at B20 and Durbin 2011 (yellow) at B5. The animal B5 blend that passed certification testing as NOx neutral in Durbin 2013A (blue) has the highest CN benefit, where it achieved the entire B100 CN at just 5% blending. The Karavalakis 2014 B5 blend (green) had an intermediate CN benefit and may or may not change NOx.

[4] The term "significant" is used in this report only to refer to statistical significance. When a result reaches the p=0.05 level, we can be 95 percent confident that it is real. In such case, and at smaller p values, the result is said to be statistically significant.

Figure 1. Cetane Blending Behavior of Animal Blends (Solid Lines) Compared to B100 Feedstocks (Dotted Lines)



The blending behavior of the UCR blends is surprising in comparison to the McCormick study, and we find relatively little research on the CN blending behavior of animal feedstocks. All conclusions from this dataset will be influenced by the CN blending behavior of the specific animal feedstocks involved. For such conclusions to be reliable, we must be confident that the large CN boost reported for the UCR blends is both real and representative of all animal feedstocks in California. Also, only limited information is available on the sources and characteristics of the animal feedstocks.

To permit all parties to better understand the animal feedstocks that were tested, ARB should release all information that it has on the following:

- CNs (methods of determination and measured values) for the Durbin 2011 and other UCR studies;
- Physical and chemical properties of the animal feedstocks and biodiesel blends tested;
- The distribution of sources, characteristics, and properties in the population of animal feedstocks that are available for use in the California market; and
- How the specific animal feedstocks tested at UCR were selected, including any information that would demonstrate that the feedstock properties and their CN blending behavior are representative of the animal feedstock population available for use in California.

ADF B3-176 cont.

Staff's use of the terms low saturation (for soy) and high saturation (for animal) to classify biodiesel is useful to differentiate between feedstocks that will tend to decrease CN and those that will tend to increase it. However, it is not a sufficient step in that the CN change at each blend level is the determinative factor for NOx emissions, not the CN of the feedstock itself. Soy feedstocks appear to blend linearly with respect to cetane; however, animal feedstocks often lead to a highly non-linear CN response, as shown in Figure 1.

ADF B3-176 cont.

2.2.4 Development of a Cetane-based Model of NOx Impacts from Soy and Animal Biodiesel

The results presented above indicate the important role that CN plays in determining the NOx response for animal blends. Animal feedstocks tend to increase the CN of the blend above that of the CARB diesel and the CN change can be large at low blend levels. Soy feedstocks generally decrease the CN of the blend below that of the CARB diesel; for soy, the CN change at low blend levels can be smaller than the uncertainty in determining CN. The result of our work on a cetane-based model demonstrates that soy and animal blends are not categorically different fuels once their differing effect on CN is taken into accounted. Their NOx impacts can be represented by the same model as a function of blend level and the change in CN compared to CARB diesel.

The document that accompanies this report explains the development of the cetane-based model in some detail. In brief, it was developed using conventional linear regression analysis with log(NOx) emissions as the dependent variable. Intercept terms were included to represent the varying emission levels on CARB diesel for each combination of study, feedstock type, engine, and test cycle. A *b* coefficient was included to represent the change in NOx emissions for each one percent biodiesel in a blend at constant CN. A *c* coefficient was included to represent the change in NOx emissions for each one number change in CN compared to CARB diesel at constant blend level. Both soy and animal blends were included in the estimation, along with the small number of canola and UCO data points, at blend levels up to (and including) B20.

ADF B3-177

The model estimation shows that the *b* and *c* coefficients are highly significant statistically ($p < 0.0001$). The estimation results also show the following:

- The *b* coefficient has a value of +0.00156, which estimates that soy and animal biodiesel will increase NOx emissions by 0.16% for each one percent biodiesel at constant CN or by 0.8% at B5.
- The *c* coefficient estimates that +5 CNs will decrease NOx emissions by 1.5% at constant blend level. This result is completely consistent with earlier work[5] on the relationship between CN and NOx emissions in HDT engines, which also found that +5 CNs will decrease NOx emissions by 1.5% in base fuels with CN ~50.

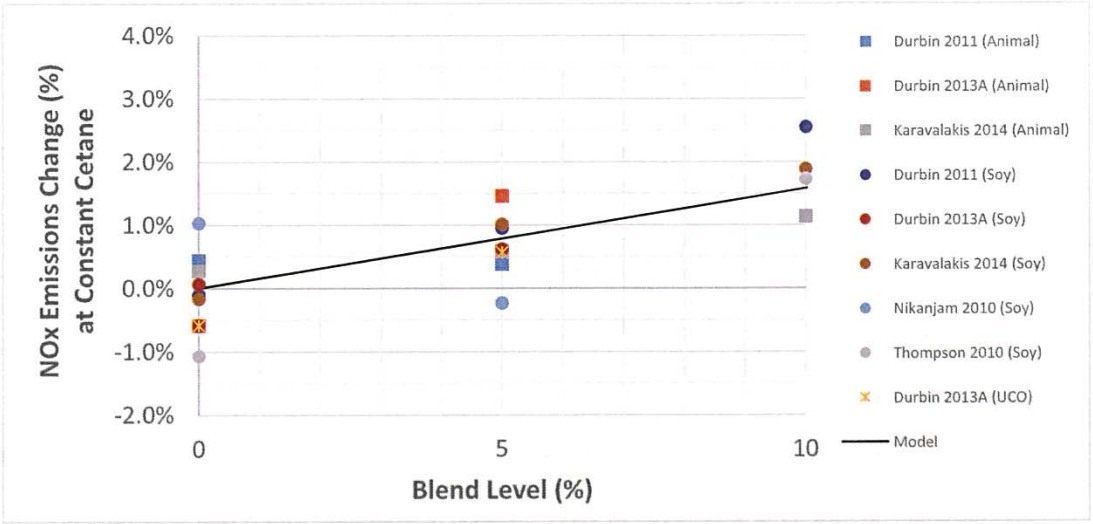
[5] The Effect of Cetane Number Increase Due to Additives on NOx Emissions from Heavy-Duty Highway Engines. EPA420-R-03-002. February 2004. Figure IV.A-1.

- An increase of -b/c = 0.5 CNs is needed to offset the NOx increase expected from each 1% biodiesel added. For B5, an increase of 2.5 CNs is required to offset the expected NOx increase.

The results explain why soy and animal blends appear to be different fuels. Soy blends have an additional, adverse CN effect that increases their NOx impact to ~1% at B5. Animal blends will generally increase CN and that reduces their NOx impact to about one-half the soy level or less, depending on the CN change caused by blending. The results also explain why some animal blends do not increase NOx emissions. If an animal feedstock increases CN by more than ~0.5 numbers for each 1% biodiesel blended, then the resulting fuel may not increase NOx emissions.

To demonstrate these conclusions, Figure 2 presents NOx emissions as a function of blend level for all fuels used to estimate the model once NOx emissions are adjusted for the CN change observed for each blend. For example, if an animal blend increased CN, then its NOx impact is increased as we return it to the base fuel CN. If a soy blend decreases CN, then its NOx impact is decreased as we return it to the base fuel CN. Once adjusted, percent changes in emissions are calculated. As seen in the figure, there is no discernable difference among feedstock types once CN changes are taken into account. Animal and soy blends scatter on both sides of the regression line, indicating that they obey the same blend level model.

Figure 2. There Are No Detectable Differences Among Feedstock Types Once NOx Emissions Are Adjusted to Constant CN



Note: Animal blends are plotted as squares, soy blends as circles, and the non-soy vegetable blends as asterisks.

Note the scatter of points around the regression line (which gives the "average" response). Some of the scatter is due simply to emissions measurement error; however, other factors may be involved in determining the NOx impact for a given feedstock, including differences in the

ADF B3-177 cont.

FAME (fatty acid methyl ester) composition and uncertainty in determining CN for the blends. If ARB were to adopt a predictive model to determine the CN improvement needed to mitigate NOx, it should use the model to evaluate a "worst case" feedstock, meaning a point near the upper end of the range at each blend level.

The most important conclusion of this work is that soy and animal biodiesel blends are not categorically different fuels. Their emissions effects are similar, but they show different NOx impacts because they have different effects on CN. Furthermore, this work provides a potential answer to the problem that some animal blends will significantly increase NOx emissions, while other blends will not, by indicating what individual blends may do.

ADF B3-177 cont.

3. NOX EMISSIONS IN NEW TECHNOLOGY DIESEL ENGINES

Staff's position is that biodiesel will not increase NOx emissions in NTDEs at levels up to and including B20. Its assessment is stated in the ISOR as follows:

> *Engines that meet the latest emission standards through the use of Selective Catalytic Reduction (SCR) have been shown to have no significant difference in NOx emissions based on the fuel used. A study conducted by the NREL looked at two Cummins ISL engines that were equipped with SCR, and found that NOx emissions control eliminates fuel effects on NOx, even for B100 and even in fuels compared against a CARB diesel baseline.[20] However, a recent study at UC Riverside tested B50 blends and found a NOx increase with a 2010 Cummins ISX.[21] The UC Riverside study did not look at blends below B50. Staff proposes to take a precautionary approach and in the light of data showing there may be a NOx impact at higher biodiesel blends but not at lower biodiesel blends, Staff is limiting the conclusion of no detrimental NOx impacts in NTDEs to blends of B20 and below. Additional studies on NTDEs have been completed, however since they included either retrofit engines or non-commercial engines Staff did not include their results in this analysis.*[22,23,24] (Page 24)

ADF B3-178 cont.

Staff's reliance on Lammert 2012 (Ref. 20) is misplaced because the NREL lab was not equipped to measure the low NOx emission levels of the test vehicles, as the abstract of the Lammert paper clearly notes.[6] In fact, none of the emission changes observed in the study (with one exception) were statistically significant due to the high standard errors that necessarily exist when measurements are made close to the level of detection. In this instance, the failure to observe statistically significant NOx emissions increases from biodiesel at the B20 level is not a demonstration that such increases do not exist.

This specific shortcoming of the Lammert study is why its negative results are in conflict with the finding of the UC Riverside study (Gysel 2014) cited by Staff and the three other studies (Walkowicz 2009, McWilliam 2010, Mizushima 2010) that Staff dismissed. With respect to the

ADF B3-179

[6] "SCR systems proved effective at reducing NOx to near the detection limit on all duty cycles and fuels, including B100." Lammert 2012, Abstract.

three other studies, we see no reason why they should be dismissed. It is not the case that factory-designed NOx after-treatment systems will reduce NOx levels to below the detection limit of well-equipped labs (see Gysel 2014 and engine certification testing). Testing conducted using retrofit NOx after-treatment systems that achieve representative levels of NOx control, as in these studies, is entirely suitable for determining whether biodiesel increases tailpipe NOx emissions on a percentage basis. Having a different absolute level of emissions does not preclude reliable measurement of a percentage change.

ADF B3-179 cont.

When all available studies are included, a consensus of the literature is that biodiesel at the B20 level will increase NOx emissions from NTDEs in most, if not all cases. Lammert 2012 is the one study at odds with the rest of the literature. A range of biodiesel types were used in the studies. NOx increases should be expected at the B20 level for all biodiesel types until such time as additional research indicates differential impacts for biodiesels derived from different sources

3.1 Review of the NTDE Literature

The following sections briefly summarize the NTDE testing conducted in the studies and the conclusions drawn on the NOx emissions impact of biodiesel fuels. Testing of conventional diesel engines without NOx after-treatment is not considered, nor is testing on non-California fuels (low aromatics ULSD was considered equivalent to CARB ULSD). Appendix Table B presents a list of the studies included in the NTDE dataset and the author references used in citations here.

Walkowicz 2009. Chassis dynamometer testing was conducted using a 2005 International 9200i tractor equipped with and without a retrofit diesel oxidation catalyst (DOC) and urea-SCR NOx after-treatment system. On-road emissions measurements also were made using a RAVEM portable emissions measurement system. A ULSD base fuel was tested, as were B20 and B99 biodiesel blends. The type of biodiesel (soy or animal) was not specified, but was mostly likely soy-based as this is the feedstock most common in the market and in engine research.

- Under loaded, on-road conditions, biodiesel increased NOx by 17% at B20 and by about 40% at B99. At B20, the increase was marginally significant ($p=0.10$); at B99, the increase was statistically significant ($p=0.05$).
- Chassis dyno testing was done 24 months later at an ARB lab. The vehicle was determined to have high oil consumption, and lubricating oil was likely present in the exhaust stream. On the UDDS cycle, biodiesel increased NOx by 7% at B20 (marginally significant at $p=0.07$) and by 35% at B99 (highly significant, $p<0.01$).

The authors concluded "The use of biodiesel did result in higher NOx emissions than the use of ULSD (in tests with statistical significance)." The B20 test results did not reach the usual $p=0.05$ level for statistical significance, but were marginally significant ($0.05 < p \leq 0.10$).

McWilliam 2010. A Caterpillar 6.61 engine equipped with DOC and urea-SCR NOx after-treatment was tested using the European non-road transient cycle (NRTC). The fuels used were ULSD plus B20 and B100 biodiesels blended from a rapeseed methyl ester. Figure 9 of the

paper shows tailpipe NOx emissions of the vehicle in g/kWh units. Reading from the graph because numerical emission values were not given, tailpipe NOx emissions increase ~15% at B20 and ~150% at B100. Based on the narrow error bars shown in the figure, both of these increases are statistically significant.

This study was conducted by Caterpillar because previous work had highlighted the potential for biodiesel to have an adverse impact on the NOx conversion efficiency of urea-SCR after-treatment systems. Thus, reductions in conversion efficiency have the potential to increase NOx emissions by amounts that exceed that caused by the biodiesel itself. At B20, only a 1% loss of conversion efficiency was noted, but a substantial 6% loss was observed at B100.

The authors of this paper concluded "Additional control strategies will be necessary to correct for NOx increases during biodiesel operation on installations requiring compliance regardless of fuel used."

Mizushima 2010. An inline 4-cylinder diesel engine equipped with DOC, diesel particulate trap (DPT), and urea-SCR NOx after-treatment system was tested using the JE-05 exhaust emissions test cycle used for heavy-duty vehicles in Japan. The fuels used were ULSD plus B20 and B100 blended from waste vegetable oil (WVO). Figure 4 of the paper shows tailpipe NOx emissions of the engine in g/kWh units. NOx emissions are highly linear with biodiesel blending level. Reading from the graph because numerical emission values were not given, tailpipe emissions increase ~20% at B20 and ~100% at B100. The paper does not address the statistical significance of these results.

With respect to NOx conversion efficiency, the study noted a drop from 76% on ULSD to 47% at B100, with a smaller but still measurable drop at B20. The impact on NOx conversion efficiency was linked to the effect of biodiesel in lowering the overall NO_2/NOx ratio at the SCR inlet leading to reduced conversion efficiency.

The authors drew no conclusions regarding the NOx emissions effects of B20 biodiesel as the focus of their research was on the B100 fuel.

Lammert 2012. The NREL study examined NOx emissions from transit buses on both EPA and CARB diesel fuels, B20 soy blends of each, and B100 soy. Chassis dynamometer testing was conducted using the Manhattan Bus (MAN), Orange County Transit Authority (OCTA) and UDDS test cycles. Two of the buses were NTDEs, including a 2010 Cummins ISL and 2011 Gillig/Cummins ISL. Only the 2010 Cummins was tested using the CARB ULSD base fuel and the biodiesel fuels.

NOx emission results for the 2010 Cummins bus are shown in Figure 10 of the paper. For B20, NOx emissions decreased compared to CARB ULSD on all three cycles (MAN, OCTA, and UDDS), and for B100 on the MAN cycle (OCTA and UDDS were not tested). None of the differences were statistically significant except for B20 on the UDDS cycle, and the standard errors plotted in the figure are large in comparison to the emission averages.

The authors explain the non-significance of their results as follows:

> *For much of the cycle NOx would be at or near the detection limit of the laboratory equipment, which resulted in a 95% confidence interval error that was high relative to the value of the cycle emissions.* (Page 6)

One of the authors' conclusions is that SCR NOx after-treatment appears to nearly negate the effect of fuels on NOx emissions. Another conclusion is that SCR NOx after-treatment also negates any duty cycle effect on NOx. (Page 8) For buses without NOx after-treatment, NOx emissions are strongly related to the kinetic intensity (load) of the test cycle. This result is consistent with all past vehicle and engine research studies, which show that NOx emissions are increased when a diesel engine is operated under increased load. However, no such relationship is observed for SCR-equipped buses. Increased load will increase engine-out NOx levels in an SCR-equipped bus. Unless this is accompanied by an increase in NOx conversion efficiency, tailpipe NOx emissions should also increase. Neither conclusion is reliable because of the study's problems in measuring NOx emissions even on ULSD fuel.

Gysel 2014. A 2010 Cummins ISX-15 equipped with DOC, DPF and urea-SCR NOx after-treatment was tested on CARB ULSD and B50 biodiesel blended from soy, waste cooking oil (WCO) and animal fat feedstocks. Chassis dynamometer testing was performed at CE-CERT using the UDDS test cycle.

Figure 7 of the paper shows the NOx emissions measured on ULSD and the three B50 biodiesel blends. The soy and WCO B50 blends increased NOx by 43% and 101%, respectively, with both increases being highly statistically significant ($p<0.01$). The animal B50 blend increased NOx by 47%, which was marginally significant ($p=0.065$). The authors' conclude that "Overall, NOx emissions exhibited increases with biodiesel for both vehicles with the differences in NOx emissions relative to CARB ULSD being statistically significant for the new Cummins ISX-15 engine." (Page 6)

The authors note the negative results reported by Lammert 2012 as being in contrast to those of their study, "which shows that there is a relatively strong fuel effect with the B50 blends compared to CARB ULSD from the Cummins ISX-15 engine with SCR." (Page 6). They also note the following:

> *The NOx increase with biodiesel for SCR-equipped engines is usually attributed by a reduction of exhaust temperature and the change of NO_2/NO ratio in NOx emissions [38]. In general, the lower exhaust temperatures with biodiesel will lower the oxidation rates of NO to NO_2 from the DOC. It has been shown that a NO_2/NOx ratio below 0.5 significantly changes SCR reaction chemistry lowering the SCR removal efficiency of NOx [39]. Walkowicz et al. [40] found increases in NOx emissions of 7% with B20 and 26% with B99 compared to ULSD for a heavy-duty diesel vehicle equipped with a 2004 Caterpillar 400 hp C13 engine. For the same vehicle equipped with a urea-based SCR system, NOx increases were very similar on a percentage basis, with B20 and B99 having 7% and 27%, respectively, higher NOx than ULSD.* (Page 6)

The authors continue to say:

> *The trend of increasing NOx emissions for biodiesel blends is consistent with a wide range of studies found in the literature. Comprehensive investigations conducted by Mueller et al. [41] and Sun et al. [42] confirmed that biodiesel promotes a combustion process that is shorter and more advanced than conventional diesel, which contributes to the formation of thermal NOx. The higher NOx emissions with biodiesel for both vehicles could also be a consequence of the higher oxygen content in biodiesel, which enhances the formation of NOx. The lower volatility of biodiesel compared to diesel fuel could also contribute to decreased fractions of premixed burn, as a result of fewer evaporated droplets during the ignition delay period [43]. Another contributing factor for NOx emissions increase could be the engine control module (ECM), which may dictate a different injection strategy based on the lower volumetric energy content of biodiesel. Eckerle et al. [44] suggested that a higher fuel flow is required with biodiesel compared to diesel fuel for an engine to achieve the same power. The ECM interprets this higher fuel flow as an indicator of higher torque, and therefore makes adjustments to engine operating parameters that, under certain operating conditions, increase NOx emissions.* (Page 6).

The engineering mechanisms described by the authors indicate that biodiesel should be expected to increase NOx emissions in NTDEs at blend levels below the B50 examined in the study. There is no basis in these mechanisms to believe that biodiesel will not increase NOx emissions at B20 but will increase NOx emissions at B50.

ADF B3-180

3.2 Consensus on Biodiesel NOx Impacts

Table 2 presents a summary of the available literature on the NOx emissions impact of biodiesel at the B20 blend level. Four of the five studies tested B20 fuels on NTDEs. Staff choose to rely on the one study in which NOx emissions were at or near the detection limit of the laboratory equipment for much of the test cycle on each fuel and to dismiss the other three studies "... since they included either retrofit engines or non-commercial engines ...". The study that was retained did not observe a NOx increase because it had trouble measuring NOx emissions from the NTDE tested. The studies that were dismissed showed consistent NOx emission increases in the range of 10-20% at B20.

Staff notes the Gysel study, which found significantly increased NOx emissions at B50 compared to CARB ULSD, as its reason for setting the biodiesel control level at B20 for NTDEs. However, Staff did not note the study's discussion indicating that the Lammert results were in contrast to their results and to the results of other studies in the literature. Nor did Staff note the discussion of mechanisms by which biodiesel is believed to increase NOx emissions in NTDEs. These mechanisms include a reduction of the NO_2/NOx ratio that leads to loss of NOx conversion efficiency in urea-SCR systems, promotion of a combustion process that contributes to increased formation of thermal NOx, higher NOx emissions due to the oxygen content of biodiesel, and the lower volatility and lower volumetric energy content of biodiesel. These mechanisms indicate that biodiesel can be expected to increase NOx emissions in NTDEs at blend levels below the B50 examined in the study.

ADF B3-181

Table 2. Summary of NTDE Literature on NOx Emissions Impact of B20

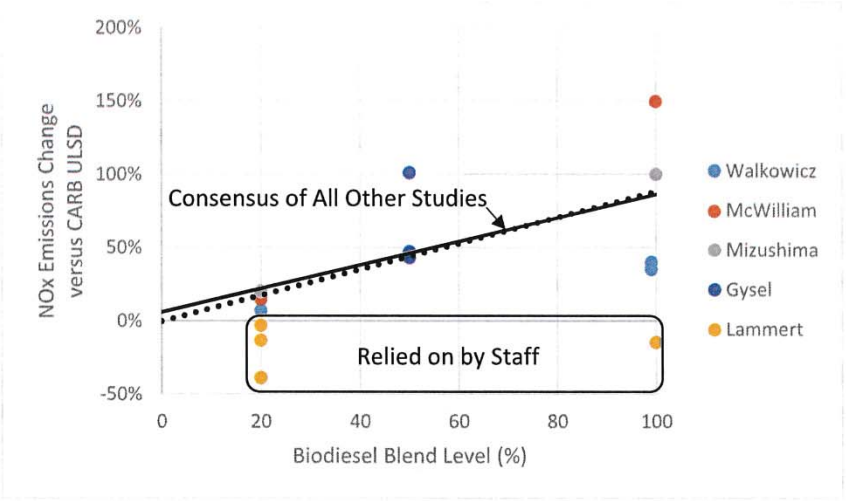
	B20 NOx Emissions Change (%) versus CARB ULSD	Comments
Studies Relied on by Staff		
Lammert 2012	NOx emissions decrease on three cycles	UDDS cycle decrease is statistically significant. NOx emissions on all fuels were at or near the detection limit of the laboratory equipment.
Gysel 2014	B20 not tested	The paper discusses how biodiesel effects NOx emissions. These mechanisms suggest that biodiesel should increase NOx emissions at levels below B50.
Studies Dismissed by Staff		
Walkowicz 2009	+17% on-road + 7% chassis dyno	Both results are marginally significant ($0.10 \leq p < 0.05$)
McWilliam 2010	~15% increase	European transient cycle
Mizushima 2010	~20% increase	Japanese heavy-duty test cycle

ADF B3-182

Figure 3 summarizes the impact of biodiesel on NTDE NOx emissions at all blend levels. The four studies (excluding Lammert 2012) establish a linear relationship between NOx emissions and blend level. The first trend line (solid black) passes very nearly through the origin without being constrained to do so. The second trend line (dotted black) is constrained to pass through the origin. While there is substantial scatter around the trend lines, the consensus of the four studies is that biodiesel increases NOx by 18-22% at B20, by 45-50% at B50, and by 90-100% at B100.

In spite of this consensus, Staff chose to rely only on the Lammert 2012 study, which shows that biodiesel decreases NOx emissions at both the B20 and B100 blend levels. This is the study that had difficulty measuring NOx emissions because NOx was at or near the detection limit of the laboratory equipment for much of the test cycle on all fuels.

Figure 3. The Impact of Biodiesel on NTDE NOx Emissions



To test the statistical significance of the trend lines shown in the figure, conventional regression analysis was conducted using the data reported by four of the studies (Lammert 2012 excluded) as summarized in Table 3. Regression A corresponds to the figure's solid trend line and is not constrained to pass through the origin. Its slope is +0.80% increase per 1% biodiesel in the blend; it is statistically significant at the p=0.035 level. Regression B corresponds to the dotted trend line and is constrained to pass through the origin. Its slope is +0.89% increase per 1% biodiesel, and it is statistically significant at the p<0.001 level. The two regression models predict a 22% and 18% increase, respectively, in NOx emissions at B20 in NTDEs.

ADF B3-183

Table 3. Statistical Significance of Biodiesel NOx Effect in NTDEs

	Intercept	Significance	Slope (% NOx Increase per 1% biodiesel)	Significance	Predicted NOx Increase at B20
Regression A	6.4	p = 0.80	+0.80% (±0.32%)	p = 0.035	22%
Regression B	None	n/a	+0.89% (±0.16%)	p <0.001	18%

A fair reading of the technical literature would lead Staff to expect that biodiesel will increase NOx emissions in NTDEs by about 20% at B20 and by proportionately smaller amounts at blend levels below B20. At the B5 level, the impact is expected to be an increase in NOx emissions of about 5%. At the B20 level, the NOx increase appears to be greater on a percentage basis than would be expected in conventional diesel engines (1% at B5, 2% at B10, and ~4% at B20). The

loss of NOx conversion efficiency when biodiesel fuels are used is one likely reason for the greater impact. ADF B3-183 cont.

4. SUMMARY AND CONCLUSIONS

The key conclusions of this study are summarized below with respect to conventional diesel engines and new technology diesel engines.

Conventional Diesel Engines

- Soy and animal blends are not categorically different fuels once their differing effect on blend CN is taken into account. ADF B3-184
- There is no evidence in the data of a threshold level below which biodiesel fuels as a group do not increase NOx, whether soy or animal. As shown here, the magnitude of the NOx impact observed depends on both the blend level and the change in CN that results from blending of the biodiesel feedstock. ADF B3-185
- Soy blends clearly and significantly increase NOx by ~1% at B5 and by ~2% at B10. The effect is continuous and linear with respect to the blend level at all levels above ULSD. Soy blends require mitigation at all levels to offset increased NOx emissions. ADF B3-186
- Staff's proposal requires NOx mitigation in summer months for soy fuels at blend levels greater than B5. Because soy fuels increase NOx at all blend levels, mitigation should be required for B5 and lower blends to prevent increased NOx emissions. ADF B3-187
- Animal blends are more complicated. The current research is limited, and the evidence is mixed. At least one B5 animal blend significantly increased NOx, while another has been certified as NOx neutral. Other B5 animal blends may or may not increase NOx depending on their CN effect (and possibly other factors). ADF B3-188
- Staff's assertion that no NOx increase occurs at B5 in animal blends is incorrect: some animal blends will significantly increase NOx emissions, while other animal blends will not. ADF B3-189
- Animal blends cannot be assumed to have no impact on NOx emissions without a demonstration that feedstock blending raises CN enough to offset potential NOx increases. ADF B3-190

New Technology Diesel Engines

- Staff is incorrect in concluding that biodiesels will not increase NOx in NTDEs. The Staff conclusion is based on a highly selective reading of the technical literature that relies on the one study in which the laboratory was not well equipped to measure the low levels of tailpipe NOx emissions from NTDEs. ADF B3-191

- There is greater reason to exclude the study Staff relied on than the three studies that Staff excluded. If that is done, there are no test data at the B20 level or below in NTDEs and no basis whatsoever to permit biodiesel fuels in NTDEs in California. ADF B3-192

- While the available data are limited, the four best studies (excluding Lammert 2012) support the conclusion that biodiesel increases NOx by 18-22% at B20 and that the increase is statistically significant. Staff has no basis to claim that no NOx impacts are associated with biodiesel at the B20 level and below in NTDEs. ADF B3-193

- A fair reading of the technical literature would lead Staff to expect that biodiesel will increase NOx emissions by about 20% at B20 and by proportionately smaller amounts at lower blend levels. This is a greater percentage NOx increase in proportion to blend level than the increase caused by soy biodiesel in conventional diesel engines (1% at B5, 2% at B10, and ~4% at B20). ADF B3-194

- Staff makes no mention of the concern that the use of biodiesel fuels may lead to the loss of NOx conversion efficiency in urea-SCR after-treatment systems by shifting the NO_2/NOx ratio to lower values. Conversion losses were observed at B20 in two of the studies. ADF B3-195

Based on the results summarized above, it is strongly recommended that ARB consider as part of the ADF rulemaking a regulatory structure in which the NOx impacts of soy and animal biodiesel are accounted for using a statistical model analogous to the Predictive Model for RFG. We see the cetane-based model presented here as a possible draft for a biodiesel predictive model, but substantial additional work is needed to: ADF B3-196

- Demonstrate that blends mitigated using DTBP obey the same model; and

- Further assess the impacts of biodiesel produced from animal feedstocks on both CN gain in blends as well as NOx emissions.

Further, more advanced statistical techniques should be used as was done in developing the Predictive Model for California Reformulated gasoline. The dataset used here is unbalanced, meaning that there are varying numbers of data points for each combination of study, feedstock type, engine, and test cycle. In fact, only a fraction of all possible study/feedstock/engine/test cycle cells are represented by one or more data points. Mixed Effects modeling is appropriate in such cases and its use will assure that coefficient estimates are not biased by the unbalanced distribution of the data. ADF B3-197

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APPENDIX TABLE A: REFERENCES TO LITERATURE ON CONVENTIONAL DIESEL ENGINES

Author	Title	Feedstocks Studied	Blends Studied
Clark 1999	Transient Emissions Comparisons of Alternative Compression Ignition Fuel	Soy	B20
McCormick 2002	Fuel Additive and Blending Approaches to Reducing NOx Emissions from Biodiesel	Soy, UCO	B20
McCormick 2005	Regulated Emissions from Biodiesel Tested in Heavy-Duty Engines Meeting 2004 Emissions	Soy, Canola, Animal	B20
Eckerle 2008	Effects of Methyl Ester Biodiesel Blends on NOx Emissions	Soy	B20
Nuszkowski 2009	Evaluation of the NOx emissions from heavy duty diesel engines with the addition of cetane improvers.	Soy	B20
Nikanjam 2010	Performance and emissions of diesel and alternative diesel fuels	Soy	B5, B20
Thompson 2010	Neat fuel influence on biodiesel blend emissions	Soy	B10, B20
Durbin 2011	Biodiesel Characterization and NOx Mitigation Study	Soy, Animal	B5, B10, B20
Durbin 2013A	CARB B5 Preliminary and Certification Testing	Animal	B5
Durbin 2013B	CARB B20 Biodiesel Preliminary and Certification Testing	Soy, UCO	B20
Karavalakis 2014	CARB Comprehensive B5/B10 Biodiesel Blends Heavy-Duty Engine Dynamometer Testing	Soy, Animal	B5, B10

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APPENDIX TABLE B: REFERENCES TO LITERATURE ON NEW TECHNOLOGY DIESEL ENGINES

Author	Title	Feedstocks Studied	Blends Studied
Walkowicz 2009	On-road and In-Laboratory Testing to Demonstrate Effects of ULSD, B20 and B99 on a Retrofit Urea-SCR Aftertreatment System	Soy?	B20, B99
McWilliam 2010	Emissions and Performance Implications of Biodiesel Use in an SCR-equipped Caterpillar C6.6	Rapeseed	B20, B100
Mizushima 2010	Effect of Biodiesel on NOx Reduction Performance of Urea-SCR System	WVO	B20, B100
Lammert 2012	Effect of B20 and Low Aromatic Diesel on Transit Bus NOx Emissions Over Driving Cycles with a Range of Kinetic Intensity	Soy	B20, B100
Gysel 2014	Emissions and Redox Activity of Biodiesel Blends Obtained from Different Feedstocks from a Heavy-Duty Vehicle Equipped with DPF/SCR Aftertreatment and a Heavy-Duty Vehicle without Control Aftertreatment	Soy, WCO, animal	B50

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3_B_ADF_GE Responses (Page 529 – 558)

254. Comment**: ADF B3-155 through ADF B3-168, ADF B3-170 through ADF B3-183, ADF B3-185 through ADF B3-196**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

255. Comment: **ADF B3-153**
The comment summarizes the commenter's NOx findings for B5 and B10 levels for both soy- and animal-based blends.

Agency Response:
The comment does not constitute an objection or recommendation regarding the proposal released in December 2014.

256. Comment: **ADF B3-154**
The comment contends that as fleets are increasingly be made up of NTDEs, the NOx increase appears to be greater than if conventional diesel was used, despite NTDEs.

Agency Response:
Please see response to comment **ADF 17-4**, which can be found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

257. Comment: **ADF B3-169**
The comment proposes that soy biodiesels adversely affect CN and animal biodiesel increase CN.

Agency Response:
The comment does not constitute an objection or recommendation regarding the proposal released in December 2014.

258. Comment: **ADF B3-184**

Agency Response:
The comment is duplicated in **ADF B3-147.**

259. Comment: **ADF B3-197**

Agency Response:
The comment is a duplicate of comment **ADF B3-146.**

Jim Lyons

From: Jim Lyons
Sent: Wednesday, February 18, 2015 11:32 AM
To: 'Mitchell, Alexander (Lex)@ARB'; 'Aguila, Jim@ARB'
Cc: 'cotb@arb.ca.gov'; 'Sideco, Katrina@ARB'
Subject: Comments on the LCFS and ADF rulemaking proposals
Attachments: BioDieselNOxAssessment20150210.pdf; Statistical Analysis; Sharp_20150218_111952_0000d3b16c98.pdf

Jim and Lex:

I have discovered that one attachment to my Declaration included in electronic filing for Growth Energy that Josh Wilter of my staff made yesterday was not included in the upload. I am enclosing the attachment here. The contents of this attachment do not differ from the content of my Declaration, and the bulk of the analysis in the attachment was provided to the ARB staff on October 24, 2014 as workshop comments. That email is also attached.

Jim Lyons

Jim Lyons

From: Jim Lyons
Sent: Friday, October 24, 2014 6:38 AM
To: Scheehle, Elizabeth@ARB; amitchel@arb.ca.gov; Aguila, Jim@ARB
Cc: rincon-ranch@earthlink.net
Subject: Statistical Analysis
Attachments: BioDieselNOxAssessment2014.pdf; Biodiesel Emissions Analysis TechnicalSummary 102014.pdf

Please find attached a slide deck and short narrative describing the statistical analysis performed by Robert Crawford of Rincon Ranch Consulting that I summarized during my presentation at Monday's ADF workshop. Please direct any questions regarding the work to Robert who is copied on this email. As was also discussed on Monday, I request that these materials be posted along with the other materials from Monday's workshop on the CARB website.

Thank you.

Jim Lyons

Jim Lyons

From: Jim Lyons
Sent: Wednesday, February 18, 2015 3:37 PM
To: 'Mitchell, Alexander (Lex)@ARB'; 'Aguila, Jim@ARB'
Cc: 'cotb@arb.ca.gov'; 'Sideco, Katrina@ARB'
Subject: Comments on the LCFS and ADF rulemaking proposals

Jim and Lex:

Just wanted to let you know that we'll be filing the report in hard-copy form tomorrow at the hearings. We tried to file a hard copy version today with the Clerk of the Board, but were instructed instead to bring hard copies tomorrow to the hearing room for filing.

I'd only planned to bring two copies tomorrow (one for each rulemaking file based on my conversation today with Steve Adams) as we don't plan to offer oral testimony on this issue and therefore don't plan to ask that the report be handed around to the Board members. However, please let me know if you'd like me to bring hard copies for you. If you were able review to our October 24 post-workshop comments that were submitted to you then as part of the ADF rule development process, you've already seen the Rincon Ranch analysis of the biodiesel test data and the related literature, which I had summarized at the October 20 workshop. The only new thing in this version of the report is the NTDE discussion, which is also covered in my Declaration that was filed yesterday.

Jim Lyons

3_B_ADF_GE Responses (Page 559 – 561)

260. Comment**: Emails from Jim Lyons**

Agency Response: The emails pertain to the submittal of public comment. They do not constitute an objection or suggestion on the proposal.

C. TESTIMONY PRESENTED AT THE FEBRUARY 19, 2015 HEARING

Fourteen stakeholders testified during at the February 19 board hearing. The transcript of the testimony is reproduced below with responses following.

The following group of comments is testimony given at the First Board Hearing.

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laboratories and demonstration settings. To ensure that these fuels are available to help us transition to a low carbon future, staff is proposing new regulations that streamline the requirements for emerging alternative diesel fuels. It also will provide for robust environmental review of these fuels before they enter the market to ensure that current environmental protections are maintained.

Mr. Corey, please introduce this item.

EXECUTIVE OFFICER COREY: Yes, thank you, Chairman Nichols.

Since the initial implementation of low carbon fuel standard, significant changes have started to occur in California's fuel market which we talked about that for a while. The carbon intensity of our state's fuel pool is declining. As fuels like renewable diesel, biodiesel, natural gas, ethanol, electricity, and hydrogen are more prevalent, today's proposed regulation represents a vital step in supporting this important transition.

Staff's proposal today provides a clear pathway of commercialization of alternative diesel fuels, incorporates the best available science, and maintains our current environmental protections. In particular, the proposal will address NOx emissions related to the use of biodiesel.

The proposal works in conjunction with proposed low carbon fuel standard re-adoption you just heard about to ensure that we deploy fuels that contribute to our climate and as well as our air quality goals.

In addition, staff's proposal is part of ARB's response to the State Appeals Court decision we talked about earlier.

Now I'd like to invite Lex Mitchell of the Industrial Strategies Division to begin the staff presentation.

(Thereupon an overhead presentation was presented as follows.)

MANAGER MITCHELL: Good afternoon, Chair Nichols and members of the Board.

Today, I will presenting the proposal to establish a regulation on the commercialization of alternative diesel fuels, also called ADFs. As with the earlier item on the LCFS, we will not be asking the Board to take any approval action today.

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MANAGER MITCHELL: As an overview, there will be five portions of this presentation which are listed here. We will first discuss the need for the proposal, then provide background, and outline our regulatory development process. We will then discuss the proposed process for

approving alternative diesel fuels, the specific requirements for biodiesel as an ADF, and the impacts and benefits of the proposed regulation.

Finally, we will present potential 15-day changes.

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MANAGER MITCHELL: We will start the presentation with the need for the ADF proposal

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MANAGER MITCHELL: In order to minimize confusion, we will first cover what is and isn't considered an alternative diesel fuel under the current proposal. Examples of ADFs include biodiesel, which is already being used and is the first ADF proposed to be regulated under this process, and dimethyl ether, an ADF in the beginning stages of the environmental review process.

Both of these fuels are chemically different than conventional diesel and neither has an existing ARB specification. Examples of compression ignition fuels that are not ADFs include renewable diesel, which is a liquefied hydrocarbon chemically indistinguishable from conventional diesel and natural gas, which already has an ARB specification.

From here on, blends of ADFs, primarily biodiesel

blends, will be discussed and some familiarity with how blends are referred to as needed. Biodiesel blends are referred to as BXX, where X represents the percentage blend level. For example, B10 is a blend of the 10 percent biodiesel and 90 percent conventional diesel.

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MANAGER MITCHELL: Before we go any further, I'd like to spend some time clarifying the difference between biodiesel and renewable diesel, two terms that frequently get intermixed. Biodiesel is a fatty acid methyl ester and is chemically different from conventional diesel.

The biodiesel molecule contains two oxygen groups, unlike conventional diesel, which contains none.

Renewable diesel, on the other hand, is a hydrocarbon chemically indistinguishable from conventional diesel, but with lower aromatic content that is typically found in petroleum diesel.

Despite their differences, biodiesel and renewable diesel are complimentary fuels. Biodiesel's good lubricity and renewable diesel's good cold temperature performance can complement each other.

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MANAGER MITCHELL: Now that we've covered what ADFs are, why do we think an ADF regulation is necessary?

First of all, ADFs can deliver significant

environmental benefits. And we expect to see their volumes grow as both state and federal policies drive their supply and demand.

In order to encourage this expected increase in ADF volumes, it is essential that market certainty and regulatory clarity be provided to emerging ADFs. As these volumes increase, it is essential that ARB ensure their commercialization is done in a manner that protects environmental and public health.

The ADF proposal is designed to address all of these objectives. In addition the proposed regulation addresses one of the problems a court found with ARB's adoption of the original LCFS regulation in 2009 by addressing potential NOx impacts from biodiesel use.

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MANAGER MITCHELL: Staff has extensively studied biodiesel and renewable diesel emissions and has found that both lower GHG, PM, and toxic emission. For example, a blend of 20 percent biodiesel has been found to decrease PM by about 20 percent.

Additionally, renewable Diesel decreases NOX relative to petroleum diesel primarily due to its lower aromatic content.

Staff has found that biodiesel can increase NOx in some situations in older heavy-duty vehicles. The ADF

proposal applies the lessons learned from the evaluation process for biodiesel in order to develop a process to evaluate future ADFs. In addition, the proposal allows biodiesel use while addressing the NOx concerns recognized during biodiesel testing, maximizing environmental benefits.

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MANAGER MITCHELL: This table shows the LCFS credits generated by biodiesel and renewable diesel in 2014 and 2020. Biodiesel and renewable diesel make up a large and increasing portion of the total LCFS credits as time goes by and significantly contribute to the success of the program.

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MANAGER MITCHELL: In addition to biodiesel, which is already contributing to the LCFS, other ADFs are expected to emerge as incentives continue. Current evaluation of these fuels involves various regulations and statute. The ADF proposal would take these requirements, clarify them, and compile them into one regulatory framework, which will provide additional certainty for proponents of upcoming ADFs, such as dimethyl ether, which is currently undergoing evaluation.

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MANAGER MITCHELL: Let's move now to the

regulatory development process.

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MANAGER MITCHELL: ARB has spent the last eight years developing and conducting studies on biodiesel emissions and analyzing the results of these studies, including spending about three million for testing to understand biodiesel's impact.

In addition to the original research conducted by ARB, staff conducted a literature review and sponsored an independent statistical analysis of the data. Staff has had extensive interaction with stakeholders on our biodiesel program, including 13 public meetings to discuss testing and seven reg development workshops.

The combination of comprehensive biodiesel testing and continual stakeholder involvement and feedback led to the ADF proposal presented today.

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MANAGER MITCHELL: During the multimedia evaluation and additional review of biodiesel emissions, nitorgen oxides, or NOx, was found to be a pollutant of concern whose emissions varied by feedstock.

For example, on this graph, you can see that biodiesel derived from soy feedstocks leads to greater NOx increases than biodiesel derived from animal feedstocks. Whereas, renewable diesel decreases NOx. All of these

impacts were measured for pre-2010 heavy-duty engines. Light-duty, medium-duty, and new technology heavy-duty diesel engines have been found to have no biodiesel NOx impacts.

We'll come back to this slide later in the presentation.

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MANAGER MITCHELL: Moving on to the objectives of the proposed regulation. In development of the ADF proposal, ARB has adhered to the following objectives:

Establishment of a clear pathway for commercialization of ADFs in order to provide regulatory certainty and encourage the use of ADFs. Ensuring public health and air quality protections from ADFs used as a replacement for conventional diesel in order to ensure the integrity of our existing air pollution reduction programs. And establishment of criteria for biodiesel use and NOx emissions control, to ensure that the benefits of biodiesel use can be realized without associated degradation in ozone-related air quality.

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MANAGER MITCHELL: We will now go through an overview of the ADF proposal. The ADF proposal includes two main provisions, the general evaluation process for environmental analysis of emerging ADFs and the fuel

specifications and in-use requirements for biodiesel.

The environmental evaluation process for emerging ADFs consists of three stages, following ADFs from lab to demonstration to commercial scale.

The proposal will limit fuel volumes and consider test location. Through this review and evaluation process, the conclusion may lead to staff to develop additional in-use controls and specifications for that fuel, or if there are no detrimental effects found, only reporting may be required.

The fuel specifications being proposed for biodiesel and, in fact, the three-stage evaluation requirements are based on staff's multimedia evaluation of biodiesel, as well as renewable diesel, both of which are nearing completion and will be completed by the follow up Board hearing.

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MANAGER MITCHELL: Let's move on to the evaluation process for emerging ADFs.

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MANAGER MITCHELL: The three stage evaluation process for commercialization of ADFs was developed to evaluate environmental impacts and control potential detrimental impacts prior to the widespread use of an emerging fuel.

During this process, staff would complete a multimedia evaluation of the fuel to determine adverse emission impacts for any pollutants of concern considering offsetting factors to determine the need for in-use requirements or fuel specifications for the ADF. The mechanism for dealing with pollutant increases would be to set a pollutant control level above which pollutant reduction strategies would be required.

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MANAGER MITCHELL: This graphic shows the three stages and hypothetical volumes of fuel distributed as the fuel progresses through the stages. Initially, an ADF proponent would apply for a pilot program under Stage 1, which would include disclosure of ADF composition, preliminary emissions testing, evaluation of potential environmental and health effects, and volumetric limit of no more than one million gallons per year.

In Stage 2, the focus is on fuel specification development and would include a full multimedia evaluation, consensus standards development, consideration of engine concerns, determination of potential adverse emission impacts, and volumetric limit of 30 million gallons per year.

After completing Stage 2, a fuel may advance to either Stage 3A or 3B, depending on its environmental

impacts. If adverse emission impacts are found, the fuel would be regulated under Stage 3A, which includes development of in-use requirements and fuel specifications. If a fuel is found to have no detrimental impacts, it would be eligible for Stage 3B, where only reporting is required.

As noted earlier, this three stage process is reflective of current regulatory requirements and policies already in place.

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MANAGER MITCHELL: Let's move now to the biodiesel specific requirements of the proposal.

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MANAGER MITCHELL: In order to control the NOx increases from biodiesel, staff developed specific in-use requirements and fuel specifications. The proposal included reporting provisions which begin in 2016, but in-use requirements do not begin until 2018. This time lime allows for implementation of mitigation options for compliance pathways.

A pathway for certification of additional in-use options has been included to allow testing of novel methods the offset NOx emission, including novel Additives, blend stocks, or production methods.

The biodiesel in-use requirements will sunset

when vehicle miles traveled in the on-road heavy-duty fleet is greater than 90 percent new technology diesel engines. This is currently anticipated to occur by 2023. Additionally, the biodiesel provisions will undergo a program review to be completed by 2020.

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MANAGER MITCHELL: Beginning in 2018, biodiesel would be limited to B5 or B10, depending on feedstock and season. Feedstocks under this proposal would be distinguished by cetane number rather than prescription of feedstock source and cetane cutoff for determining feedstock is 66.

Higher cetane biofuels such as animal-based biodiesel tends to produce less NOx than lower cetane biodiesel, such as soy-based biodiesel, and therefore be used in higher blends.

Additionally, blends up to B20 could be sold if they use an additive or other certified control. Biodiesel used in light-duty and medium-duty vehicles has been shown not to increase NOx. Newer heavy-duty vehicles have been shown not to experience the NOx increase from biodiesel as well that is seen in older heavy-duty vehicles due to the use of selective catalytic reduction emission controls. The ADF proposal includes an exemption process for these vehicles.

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MANAGER MITCHELL: You'll recall this slide from earlier. The important point here is that our extensive testing showed that biodiesel are not created equally and the different feedstocks result in different NOX effects. Just as importantly, our testing also showed the offsetting effect on NOx from the use of renewable diesel. These two findings informed the proposed regulation.

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MANAGER MITCHELL: As part of staff's analysis of the effects of biodiesel use, offsetting factors were considered to determine the real world effect of its use, rather than simply the lab results of engine testing.

Most importantly, it was found that new heavy-duty new technology diesel engines or or NTDEs do not experience a NOx increase with biodiesel up to B20 due to SCR emission controls and the heavy-duty market is substantial and increasingly complied of NTDEs.

Additionally, the NOx decrease from renewable diesel means that some of the emissions from biodiesel are offsetting, leading to less need for in-use requirements on biodiesel, especially considering the recent and expected continual increase in volumes of renewable diesel. These offsetting factors combine to eliminate the NOx increase from biodiesel over time, hence the sunset

provisions, by in the mean time controls on NOx are needed.

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MANAGER MITCHELL: This graph shows the increase in vehicle miles traveled by new technology diesel engines as well as the NOx increase from biodiesel.

As newer vehicles become an increasingly large contributor, the vehicle miles traveled in the on-road heavy-duty diesel fleet as shown by the shaded bars. The corresponding NOx increase from biodiesel becomes increasingly reduced.

As you can see, in 2023, when newer vehicles are expected to contribute more than 90 percent VMTs, the NOx increase from biodiesel becomes negligible. At that point, we are proposing to sunset the biodiesel in-use requirements.

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MANAGER MITCHELL: Practically speaking, we expect regulated entities to comply with the regulation primarily by selling biodiesel blends at or below a B5 blend level.

However, the proposed includes other options that will increase flexibility for compliance which are listed here. For example, for businesses geared toward B10 sales, either a high cetane feedstock may be used or any

feedstock may be used in the winter.

For businesses geared toward B20 sales, either targeted sales to exempt vehicles or additive use will accommodate these sales. The table on this slide shows the NOx control level by both feedstock and time of year, which lead to these compliance options.

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MANAGER MITCHELL: As was mentioned earlier, the NOx emissions from biodiesel are expected to decrease over time leading to a sunset of the in-use requirements when new heavy-duty on-road trucks are more than 90 percent of vehicle miles traveled. This is expected to occur by 2023.

Additionally, as the fuel market is still in flux in its transition to diesel substitutes, a review of the program will be completed by 2020. This review will consider a variety of factors, such as SCR adoption and fuel volumes, and whether we are on the right trajectory toward the projected sunset of biodiesel blend limits.

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MANAGER MITCHELL: Let's move now to the impacts and benefits of the alternative diesel fuels proposal.

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MANAGER MITCHELL: Staff prepared one draft environmental analysis, or EA, that covered both the

proposed LCFS and ADF regulations because two rules are interconnected. The draft EA was prepared according to the requirements of ARB's certified regulatory program under the California Environmental Quality Act, or CEQA. The analysis focused on changes in fuel production supply and use. The existing regulatory and environmental setting or the actual physical environmental conditions in 2014 is used as a base line for determining the significance of the proposed regulations impacts on the environment.

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MANAGER MITCHELL: As discussed in the previous presentation for LCFS, the draft environmental analysis identified both beneficial impacts and adverse environmental impacts from the proposed regulation.

Beneficial impacts were identified in the areas of reduced GHG emissions, reduced criteria pollutants, including reduced PM2.5 emissions and energy. The draft EA identified less than significant impacts to certain resources such as minerals and recreation.

Potential significant impacts were identified in a number of resource categories such as agriculture, biological, and hydrology and water quality. Significant cumulative impacts were also identified for resources.

While some of these identified impacts are

related to long-term operational changes, others are potential short-term effects related to construction of new fuel production facilities.

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MANAGER MITCHELL: The economic impacts of the ADF proposal were evaluate in two ways, as part of a state-wide macro economic evaluation of the effects of the ADF and LCFS proposals and as the direct costs of the ADF proposal provisions.

Because the ADF and LCFS proposals were so interlinked, the macro and economic impact of the proposals could not be desegregated and therefore the evaluation was completed using the simultaneous effects of both proposals on fuel volumes and prices.

As was discussed in the LCFS presentation, the macro economic evaluation employed a conservative framework and found that the combination of proposals would have a very small impact on the overall state economy.

Compliance with the ADF provisions are expected to result in costs of about one-tenth of a cent per gallons on B5 diesel in 2018. And as the fleet transitions to newer engines is expected to shrink and eventually be eliminated by 2023. For biodiesel producers whose business is reliant on sales of higher biodiesel

blend levels and who are not located near a terminal with biodiesel blending facilities, there are will be additional challenges to the regulation.

Staff continues to work with stakeholders to identify additional flexibility to address this challenge while maintaining the NOx protections of the proposal.

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MANAGER MITCHELL: The primary reason why alternative diesel fuels and other diesel substitutes are important and should be encouraged is due to their variety of beneficial impacts. For example, biodiesel, renewable diesel, and dimethyl ether can all reduce PM and toxics compared to conventional diesel, leading to lower localized toxic exposure, and renewable diesel can reduce NOx emissions.

All of these fuels can be produced from feedstocks that lower greenhouse gas emissions and are capable of contributing to our 2020 and 2030 air quality goals. Additionally, all of these fuels can be produced from domestic sources produced in the USA, leading to increased energy security.

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MANAGER MITCHELL: We will now move on to 15-day changes and next steps.

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MANAGER MITCHELL: Staff has included some potential 15-day changes for consideration in Attachment A of the Resolution. Examples of potential changes include further flexibility for captive fleets that would not adversely effect air quality, clarification of certification procedures, definitional changes, and minor clarifications, and corrections.

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MANAGER MITCHELL: This is the first of two Board hearings so the Board will not adopt the ADF today. We recommend that the Board direct staff to continue working with stakeholders to refine the proposal and coordinate development with the LCFS team.

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MANAGER MITCHELL: Going forward, staff will complete and respond to comments on the environmental analysis document. The peer review of our biodiesel multimedia evaluation is in progress and the multi-media process will be completed by the second Board hearing.

Staff will also propose 15-day changes for comment prior to the second Board hearing.

Thank you for your attention. This concludes staff's presentation. I would be happy to answer any questions you may have.

CHAIRPERSON NICHOLS: We do have 14 witnesses who

have signed up. But yes.

BOARD MEMBER SERNA: Thank you, Madam Chair.

Quick question for staff on the chart that you showed twice that showed the NOx effect of biodiesel in older heavy-duty vehicles, are you encouraging us not to get too hung up on the soy feedstock biodiesel because that's only applicable to the older engines. And with the introduction of newer engines that that NOx concern will go away?

MANAGER MITCHELL: I wouldn't characterize it as the difference in the feedstocks. We think that the NOx effect goes away over time, like you said, due to the newer vehicles. More or less what the proposal does is it assumes that unless you take an action and use a cleaner feedstock that you're using one of the soy feedstocks, which we consider the lower cetane fuels.

ASSISTANT DIVISION CHIEF KITOWSKI: Maybe I can recharacterize that a little bit.

The use of soy and animal as part of the testing programs, but they weren't very good metrics for regulation. So in moving from the test program to the regulation, we shifted from soy and animal feedstocks to high saturation or high cetane and low saturation low cetane. They're area pretty much analogous.

BOARD MEMBER GIOIA: Thank you.

CHAIRPERSON NICHOLS: Before we go, you have a question?

BOARD MEMBER ROBERTS: You'll have to indulge me. I know I'm the only one that doesn't know the answer to this.

The difference between biodiesel and renewable biodiesel? And why do they call it renewable because it doesn't seem like it's renewable?

MANAGER MITCHELL: Biodiesel and renewable diesel are both produced from the same feedstocks. Those are any fat or oil that you can find.

The difference is in the processing. So the biodiesel process is it takes this kind of lighter chemical treating to create this fatty acid methyl ester, which is a distinct type of chemical.

Renewable diesel takes those same feedstocks and it uses a more similar to a refinery process a hydro treating process to create a fully non-oxygenated saturated fuel.

The reasoning why they're called something different I think is that biodiesel was kind of the first adoptor of this technology so that biodiesel was there first. And then to distinguish, they just wanted to make sure that what people are calling fatty acid methyl esters is biodiesel and it's different from renewable diesel,

which came along later. So it's not that one is renewable, one's not.

CHAIRPERSON NICHOLS: Renewable sounds good and --

BOARD MEMBER ROBERTS: It sounds like it's going to be there after you use it. So --

CHAIRPERSON NICHOLS: It's just terminology.

BOARD MEMBER ROBERTS: It's in the process you're starting with similar products. And that's where the --

MANAGER MITCHELL: Transetherification is the chemical process for producing biodiesel and hydro treating is the chemical process for producing renewable diesel.

BOARD MEMBER ROBERTS: You made it so crystal clear.

CHAIRPERSON NICHOLS: The whole concept of fatty acids is not really worth talking about.

BOARD MEMBER GIOIA: There is a good band name in there somewhere.

CHAIRPERSON NICHOLS: With that, I think we should proceed to hearing from the witnesses. So we'll start with Matt.

1_T_ADF _SCAQMD

MR. MIYASATO: Thank you, Madam Chair.

For the record, Matt Miyasato, the Deputy Executive Officer for Science and Technology Advancement

ADFT1-1

at the South Coast Air Quality Management District.

I'm here to voice our support for the staff recommendation and your ultimate approval of the ADF regulation.

I also want to point out that you've heard a lot of accolades about your staff. They continue to work, go out of their way to work with us. We brought up the concerns we had over NOx increases or potential for NOx increases. And they do what we do, they rely on data to make the recommendations before your Board which is in your package today. So we appreciate staff continueing to work with us.

So again, we urge your ultimate approval when this comes before you for a vote. Thank you.

ADFT1-1 cont.

CHAIRPERSON NICHOLS: Thank you. Ms. Case.

MS. CASE: I'm going to sound like a broken record when I thank everybody again.

CHAIRPERSON NICHOLS: Could you raise the mike?

MS. CASE: Richard Corey and Lex Mitchell and everybody on the staff for all the work that they've put into this, because it really has been a lot of work. And I do appreciate it.

As I said in my earlier testimony, my biodiesel plant is in San Diego, which is one of the smaller diesel markets that is not at this point terminal blending. We

make our biodiesel from 100 percent used cooking oil captured from restaurants. So we convert french fry oil into biodiesel.

The biodiesel that we make on the our plant is one of the lowest carbon biodiesels out there, because we are making it from the used cooking oil. And it's soon to be lower as we are in the middle the project to install cogeneration at our plant, which we are really proud of.

2_T_ADF _NLB

This regulation I know was pain-stakenly arrived at over a long period of time, and I believe it represents a great compromise for all sides. I particularly support that there is the in-use time line, which will allow our business to adapt. We do sell a lot of our fuel into the B20 market. So we do need to make some changes to our business plan. And we look forward to continuing to work with staff on finding ways that we can target fleets that will not cause increased NOx and in addition work with our trade industry group on developing additives.

ADFT2-1

So thank you for everything that you've done to get to this point. And in this spirit of the Chairman's comment earlier, I'm very confident that we will innovate and adapt to these changes as we have in the past and everyone should to protect our environment. Thank you.

CHAIRPERSON NICHOLS: Okay. Thank you.

Curtis Wright? Curtis Wright here?

Celia DeBose.

MS. DE BOSE: So this is Celia DeBose again with the California Biodiesel Alliance, the industry trade association representing over 50 stakeholders.

And again, we're supporting the comments of the National Biodiesel Board and urging the adoption of this regulation. So if staff needs more kudos, kudos.

And the interesting thing about this is that it's not just you guys, but it's generations before because we really have been working on this for about ten years. What we've been engaged in is a process of bringing in new fuel to market in California. So we've marked with State agencies, helped them check off what they need to check off. And what's important now is that the Air Resources Board moved forward with this important step so that we can move forward with a structure and a process that allows us to deal with this one criteria pollutant.

So we really appreciate the exemption, the exemption for the 90 percent new technology diesel engines for heavy-duty fleets, the exemption for the light and medium duty fleets, the opportunity to create our own additive. And I was very happy to see further blend level flexibility for captive fleets as something that we can talk about. So thank you again. We really look forward to continued engagement as we finalize and implement this.

3_T_ADF_CBA

ADFT3-1

Just on another note, it's great to have our fuel recognized for its beneficial qualities. And we know that we do well under the low carbon fuel standard because we reduce greenhouse gases. But it's nice to hear you guys also recognize all the other benefits. We really look forward to bringing the health benefits to California as much as possible and especially the PM reductions that have been really noted -- Richard Corey mentioned this at our conference on February 4th saying that biodiesel is important for reductions in toxic diesel particular matter. So we do this already. We want to do it more. We want to help provide solutions in the communities that are most impacted that suffer the most from the diseases caused by diesel pollution. And a lot of our plants are located in these areas. So we're going to accomplish this by creating more good family supporting jobs. So thank you guys so much. ADFT3-2

CHAIRPERSON NICHOLS: Thank you.

MR. NEAL: Thank you, Madam Chair and members of the Board.

Shelby Neal with the National Biodiesel Board representing the biodiesel and renewable diesel industries. We are not quite as excited to be headed to the gallows as the gentleman was this morning. But we are never the less excited.

We would like to thank the ARB Board and especially staff and particularly Richard Corey for really in my 17 years in and around government unprecedented level of focus and work on an extraordinarily dull topic. So thank you really all of you for doing that.

4_T_ADF_NBB

I'm no expert in business, but Warren Buffet it often says this, he says capital goes to where it can get the highest return with predictable risks. So it's the last clause in that sentence where we've had trouble. Predictable risk. But this regulation along with LCFS readoption fixes that.

So this should move our industry from survival mode, which is surviving is better than the alternative, but it's no way to live long term. So this should move us into a more comfortable area. And in 2023, or when we can develop an additive so-called solution which we are working on already, we can thrive and we can flourish in the state. I think we will.

ADFT4-1

I want to thank ARB staff for just doing an incredible job. We stated in our public comments that we didn't think this regulation was necessary in a perfect world. But that's not intended to be a criticism. ARB has a very different mission than our industry does or other scientists who look at this. And every step they took the most conservative path, the most protective of

ADFT4-2

public health. We support that view. That's why we willingly accept these limitations. Thank you very much for your time. ADF T4-2 cont.

CHAIRPERSON NICHOLS: Mr. Teall.

MR. TEALL: Russ Teall, Biodico and currently President of the California Biodiesel Alliance.

5_T_ADF _BSB

I will try not to repeat the things that have been already said. I agree with them entirely.

But the history of this goes back to 1993. That was our first meeting with the Air Resources Board to talk about biodiesel. It was brand-new at the time. And so it's been a 22-year journey up to this point. And is it perfect? It's as close to perfect as you can get. There's been a lot of give and take, back and forth. And the complexity of the regulation reflects a desire I think to get it right. You know, it's a complex topic. And in order to balance the needs of industry with the needs of the environment, I think it's a well crafted decision. ADF T5-1

One point that needs to be made is that biodiesel substantially reduces air toxics, other than the criteria pollutants, all the polyaeromatic hydrocarbons, et cetera, we're the only fuel that's been through Tier 1 and Tier 2 health effect testing the U.S. EPA successfully. So that's a point that was recognized by staff. ADF T5-2

Thirteen public meetings, seven ADF workshops,

countless private meetings, phone calls, e-mails, I'm going to look forward to getting back to Santa Barbara at the end of this journey.

Other than thanking Richard, Floyd, and Jack have done a tremendous job, you know, transitioning Floyd in the beginning directing this entire process, setting a mood that was correct in terms of listening to industry, reacting. And I think as a two-way learning, we learn things along the way that about ARB and what the objectives are. And I think they learned as well.

So I guess in conclusion, we whole heartedly support the ADF program in part because of staff. You know, we know that staff is there. They're listening. And we look forward to continuing the dialogue during this 15-day notice period. Thank you. ADFT5-3

CHAIRPERSON NICHOLS: Thank you.

Mr. Von Wedel.

MR. GERSHEN: I think Randall left.

Thank you again. At the risk of sounding a little repetitive, the development of this ADF regulation has been a challenging process. We appreciate ARB has been mindful of all the stakeholder interests.

As I'm sure you know by now, California biodiesel industry is made up of independent producers marketers, feedstock suppliers, a variety of stakeholder feedstock,

6_T_ADF _Gershen

all sizes and shapes. A big challenge has been to be inconclusive, and ARB staff has been very attentive to our needs and demonstrating the willingness to work with our industry to help develop a variety of compliance options. And we really do appreciate that. Thank you. ADFT6-1

As mentioned in my prior comments, I'm confident that working together with ARB, California biodiesel can build on our successes. We look forward to continue working with you even more to reducing carbon emissions, lowering emissions, and creating high paying green jobs in disadvantaged community across the state. Thanks. ADFT6-2

CHAIRPERSON NICHOLS: Lisa Morenton again.

MS. MORTENSON: Hello, Chairman Nichols and members of the Board.

I sincerely appreciate the opportunity to talk about the ADF. This is a very personal issue for me. I cannot count the number of sleepless nights that I have had during the twists and turns of the development of the ADF rulemaking. So this is very important to our industry.

7_T_ADF _CF

As you know, biodiesel use in California has made a positive impact. It reduces harmful emissions and it also stimulates the economy. It's important to remember that biodiesel is an advanced biofuel that is proven. It's reliable. And it is available in commercially ADFT7-1

significant volumes. And it is our commercial success is why we are in the Stage 3 as a commercial fuel under the ADF rulemaking. So part of this is very positive. The commercial success of biodiesel have moved us into this new level of regulation.

ADFT7-1 cont.

Biodiesel does have strong public and bipartisan support, and that's because it has so many terrific benefits. It has wonderful performance benefits. It has very strong lubricity properties, which reduces wear and tear on engines, and it also has strong detergent properties.

It has terrific environmental benefits reducing harmful emissions which improve human health. And we heard from Lex Mitchell earlier that biodiesel lowers localized toxic exposure. That is so important to protect our most impacted communities. And it's also important to remember that the diesel engine is 20 to 30 percent more efficient than electric engine.

ADFT7-2

And we, of course, can't forget the economic benefits. Biodiesel creates jobs, revenues, and taxes. When you have in-state production such as what we do at Community Fuels, you're creating advanced manufacturing jobs, which have the highest multiplier effect of any industry. So biodiesel is really exciting and really good for California.

I ask you to put on your imagination cap and imagine if biodiesel were the typical diesel fuel used in California and petroleum diesel were trying to gain approval. Imagine how different that conversation would be.

We spoke about how biodiesel is ready to deliver significant volumes to California. The ADF proposal will impose limitations and constrain how biodiesel is used within the state. While I understand why the alternative diesel fuel rulemaking is necessary, I do request that CARB pay very close attention to this ADF rulemaking and to work hard to sunset this regulation at the earliest possible opportunity. ADFT7-3

We want to grow biodiesel in California. We want to realize all the benefits that biodiesel has for this state. And to do that, we need more flexibility and higher volumes of biodiesel. And just quickly, I want to thank Mr. Corey for his personal involvement in this very important issue. He made a big impacts in the direction of this regulation. Thank you.

CHAIRPERSON NICHOLS: Okay. Thank you. Extra time always allowed for thanks.

MR. SIMPSON: Madam Chair and members of the Board. Harry Simpson with Crimson Renewable Energy, biodiesel producer here in California.

Obviously, we paid very close attention over this marathon process that we've gone through in getting to where we are today with the ADF regs. I think in our company was formed in '07, and I think some of the stuff started even before that.

So we would certainly like to thank Mr. Corey and Lex and Floyd and the many others who have been on this road to get us to the proposed regs today.

I know that sounds like a broken record, but you guys really do deserve a hand for that. You guys have consistently engaged with all the different stakeholders and that was certainly no easy feat. And your willingness to do it on a very regular basis and hear what everyone had to say went to I think what many of us would call a grand compromise in terms of the regs that we have before us today.

8_T_ADF_CRE

That compromise was the product of a lot of strong data, a lot of technical analysis, a lot of fighting back and forth as to how that shook out. In the end, I think you were able to acknowledge the significant health and carbon reduction benefits that biodiesel offers and reconcile that with any issues and the need to safeguard air quality in terms of NOx.

ADFT8-1

So while it's not ideal, we fully support it. And I think it provided much needed regulatory certainty.

Like Lisa said, I, too, have had many sleepness nights wondering if the close to $30 million we have invested in our plant is going to go up in smoke. And we get essentially regulated out of business.

So I'm happy to say that's not the case, and I think the community in which we in the state of California I think last year we contributed about $40 million directly into the economy. When we're done with our expansion, it will be $80 million in 2016. It's good to see that investment will continue to make a contribution and bring much needed carbon reduction benefits to the LCFS. Thank you. We support the regs.

CHAIRPERSON NICHOLS: Great. Mr. Barrett.

MR. BARRETT: Good afternoon. I'm Will Barrett with the American Lung Association of California.

And as noted in the letter that we submitted along with our colleagues that CERT, the Coalition for Clean Air, NRDC, we support the proposed diesel regulation. You'll hear from some of the other signors of that letter in a few minutes.

9_T_ADF _ALAC

We believe the proposal successfully addresses the need for cleaner alternatives to harmful fossil fuels, with the need to ensure that no additional harm is caused by these alternatives as they come into the market or the market expands because of the potential for biodiesel to

ADFT9-1

increase smog-forming NOx emissions under certain formulations or engine models or operating conditions put forward by CARB set to avoid backsliding on NOx is appropriate.

We also do appreciate that the proposal and Lex's presentation included compliance strategies to maximize the greenhouse gas and particulate benefits of buy diesel. We encourage ARB to explore additional opportunities to capture NOx neutral and NOX reducing particulate and carbon pollution benefits of this alternative. ADFT9-1 cont.

The air pollution public health and health equity impacts of petroleum fuels are well documented and must continue to be addressed through strong regulations that get all fuels impacts on lung health in our climate. We believe the ADF proposal is an important step in this process of curbing many harmful pollutants at once and protecting the health of future generations of Californians. So I just wanted to add to the chorus and thank for the staff's work on this. And thank you all. ADFT9-2

CHAIRPERSON NICHOLS: Great. Mr. Magavern.

MR. MAGAVERN: Bill Magavern, Coalition for Clean Air in support. I did not go through all the ins and outs of this long regulatory process. I have a lot of respect for those who did. I'm very impressed with the final result.

10_T_ADF_CCA

For years, we've had this tension. I think as we heard earlier today just, about everybody other than the oil companies wants to bring lower carbon fuels to market. And we need to reduce our reliance on petroleum so there are a lot of good arguments for alternative fuels. ADFT10-1 CCA

At the same time, as air advocates, we want to make sure we're not unintentionally increasing any air pollutants. And of course, it's your mission to prevent that from happening. So I think that this balance has been struck and this regulation really achieves that. Petroleum diesel is a plague on our health, so let's bring on the biodiesel with the appropriate protections. Thank you very much. ADFT10-2

CHAIRPERSON NICHOLS: Okay.

MR. DELAHOUSSAYE: Good afternoon. Dayne Delahoussaye representing Neste Oil. Neste Oil support supports the ADF regulation and and we're advocating the Board continue forward with it.

We're glad and proud that the findings of the NOx reductions agrees with our research and our experience as well. So we are supportive of California moving forward with that step.

11_T_ADF_Neste

The one technical comment I would point out and I made this in more detail in my written submissions for both the LCFS and the ADF because they tie together is the ADFT11-1

definitional language specifically when you're discussioning this fuel.

I believe one of them calls them non-renewable diesel. The other calls it renewable. At a minimum, encourage the same terminology for both of these funds referring to the same fuel.

Additionally, the ADF goes into great pains to describe -- the fuel they described was the hydrocarbon fuel. And so we would encourage as we're trying to develop a right technology for this and consistency that renewable hydrocarbon diesel be the term we're describing so we can avoid any confusion between different usage and different markets of other uses and that kinds of stuff. For example, some Canadian jurisdictions define renewable diesel as both hydro treated and biodiesel stuff. I think having a more clear definition of what it is renewable as opposed to what it's not non-ester renewable diesel being a more appropriate and simple definition for that kind.

ADFT11-1 cont.

And as well as then align the two definitions. They both have different public parts and things like that and there is a lot of overlap, but they're not unanimous. I would encourage being at least under the same division to have a definition that is in line and in agreement with each other. And you don't have two jurisdictions within the Air Resources Board playing that game. Other

questions, I'm happy. Otherwise, thank you for your time.

ADFT11-1 cont.

CHAIRPERSON NICHOLS: Good point. Probably requires the equivalent of a spell check to be used. And make sure we use the same terms each time. Okay.

Mr. Hedderich.

MR. HEDDERICH: So 13 is much better than 45 or 46. Moving up in.

And I understand why, Chair Nichols, you pronounced my name correctly. It's misspelled. It ends in an H.

12_T_ADF _REG

I'm not going to repeat the comments you heard from other folks. We're very supportive as the nation and north America's largest biodiesel producer and also a significant producer of renewable hydrocarbon biodiesel. Very supportive of all the comments that you heard. Agree there is some definitional issues we need to work out to make sure we're using the same language.

ADFT12-1

I was going to offer to Supervisor Roberts if he wants to see what the different plants look like, happy to show him. This has been a torturous process, I'll say. It needs to come to conclusion so our industry can move forward, so we can move forward with the LCFS, so we can have some certainty. Very much appreciate all the effort that staff did to bring this issue to closure. And with that, let's move forward and get closure. Thank you.

CHAIRPERSON NICHOLS: Okay. Thank you.

Mr. Mui.

MR. MUI: Good afternoon. Simon Mui with NRDC.

We also support the adoption of the ADF regulation. And like Bill Magavern, I've been on the periphery and following and reading.

But I do have to commend staff and management for really balancing the need to achieve the GHG reduction goals while mitigating any NOx issues. And we do think that ARB -- this is one great example where ARB has really ensured as we transition to new energy sources, we are managing the trade-offs.

So I really commend staff. And I know that often times industry may have sleepless nights. I can guess that ARB and staff has had sleepless nights. Maybe as a Resolution Richard can actually take a weekend off.

13_T_ADF _NRDC

But I do want to say that this is reasonable. Our understanding is looking at the science that this is based on the best available technical studies and work. And we are very enthusiastically supporting this as maximizing both the LCFS and ADF together are really maximizing the public health benefits of these programs. Thank you.

ADFT13-1

CHAIRPERSON NICHOLS: Thank you.

And last, Mr. Fulks, from the Diesel Technology

Forum.

MR. FULKS: Madam Chair, Board members, always awesome to be batting cleanup, standing between you and going home. So I will be as brief as I possibly can.

The Diesel Technology Forum is not taking a position on ADF, but we did want to come in and acknowledge the professionalism, the courtesy, and the just plain decency of your staff in the development of not just the ADF, but also the LCFS. It's been a pleasure to work with your staff. I'm just piling on, I know.

14_T_ADF_DTF

I did want to take a yellow highlighter to the precedent-setting policy that you were engaging here with the ADF in that it is an acknowledgement that emission control systems for diesel engines will be used as a NOx mitigant for this fuel moving forward after 2018.

We did note that under the LEV III development process the notion of using fuel as a NOx mitigant for vehicle hardware was never even allowed to be considered. So this is a precedent-setting policy change that we will be taking note of as we move into the future trying to reach the Governor's 50/50/50 by 30 goals. We're going to be relying on diesel for a while to get some of these fuel economy gains.

ADFT14-1 DTF

And as there may be a clash between those goals and the ultra low NOx rule that is a voluntary rule now

ADFT14-2

but may be coming back to you as a mandatory measure. So therefore, I just wanted to plant the seed that now that the precedent has been established that you can use hardware to mitigate NOx from fuel, it may come back to you some day that maybe perhaps we can consider using fuel as a NOx mitigant for hardware down the line. ADFT14-2 cont.

So thank you for your attention. And again tip of the hat to your staff.

CHAIRPERSON NICHOLS: Well, it's an interesting comment, but I'm not really buying it.

MR. FULKS: I'll put it in the record anyway.

CHAIRPERSON NICHOLS: I'll tell you why, because I think that there is a lot of precedent for recognizing that emissions occur when fuel is used in an engine. And when you're projecting emissions, you have to look at what the engine is doing as well as what the fuel is doing.

So I don't think that position that the staff has taken here -- and I could be corrected on this -- is that the new vehicle standards are a mitigation for the fuel any more than the fuel is a mitigation for the engines when we're certifying engines. We certify engines based on a type of fuel that we assume is going to be in the marketplace. And this is the same thing in reverse.

MR. FULKS: Understood. We wanted to open the dialog as we move forward with ultra low NOx.

CHAIRPERSON NICHOLS: Always good to see you. Mr. Corey needed another round of thanks. That's great. Thank you.

Okay. That's it for the witness list. And are there any additional comments by the Board? Question, Mr. Dr. Sperling.

BOARD MEMBER SPERLING: I'm not speaking as a Board member yet. As a scientist, I look at Table 12 and I see these are really very small differences when you take into account we're talking about 50, 90, 95 percent reductions otherwise. So are there -- there's uncertainty. There has to be a lot of uncertainty here. So I'm wondering if I was looking as a scientist, I would say, okay, what are the confidence intervals here. What's probablistically, what are we talking about here. But one percentage? Two percentage? I know there is judges involved and that stuff. So that's why you I'm asking this as a scientist first.

MANAGER MITCHELL: I can parrot some of what we put in the staff report. We did do an ARB staff level statistical analysis and we commissioned a statistical analysis from an independent researcher, and they both found basically that we've got these results are statistically significant.

BOARD MEMBER SPERLING: At what level? At 90

percent?

MANAGER MITCHELL: Generally, we look if you want to, P values of .05 or less.

BOARD MEMBER SPERLING: Yeah. Okay. I had to ask that.

CHAIRPERSON NICHOLS: What does that lead you to think?

BOARD MEMBER SPERLING: That it's unfortunate we got to put it. We created this complex set of rules and, you know, burdens on companies. And it's a small effect. And I know, you know, we don't want to be -- our goal is to reduce NOx, not to increase it. But it really is a tiny amount, and it's not even relevant to anything except old engines. We've created this complex rule. So I'm kind of holding my -- I'm trying to accept it because I know we need to do it or that's my understanding because of lawsuits. But as public policy, it's kind of questionable.

CHAIRPERSON NICHOLS: Well, it's what happens when you get mixed up with CEQA.

BOARD MEMBER SPERLING: I know. That's why I don't want to be part of the next lawsuit either.

CHAIRPERSON NICHOLS: But it is -- isn't just lawsuits. But it is the law actually that requires that we be able to say with more certainty than you might like

that it will not be an increase in NOx as a result of what we're doing. That's a hard thing to prove, I know.

BOARD MEMBER SPERLING: I'll say one last thing. You could look at electric vehicles and say some -- I'm not going to go there.

CHAIRPERSON NICHOLS: You're not going there. You can think whatever you like.

Ms. Mitchell.

BOARD MEMBER MITCHELL: Thank you.

I also wanted to thank staff for working on this. And Jack Kitowski, I know he put a lot of time in it. And as you all know for South Coast, it's really important that we prevent further NOx -- increases in the NOx emissions. We have a fairly daunting task ahead of us for 2016 AQMP and our reductions that are needed by 2023 and 2032. I talked about it many times sitting on this Board. So this was a hard thing to do.

It does result in some complexity, but I think staff did a really good job working it out. And I know they worked very closely with staff at South Coast to iron out all the little wrinkles in this to get to a point where it's acceptable and will help South Coast reach the targets that we have to reach. So thank you for all the work that you've put in on it.

CHAIRPERSON NICHOLS: Thank you.

BOARD MEMBER BERG: I'd like to just make one observation as I was listening to the testimony and the regulated community, it really came to mind as I look at this and saw all of the support and the accolades for staff, but actually the accolades for the industry, because I did hear how challenging -- it was a marathon. It was torture. It's not ideal. It caused sleepless nights. And then from the environmental of our NGO friends that, you know, the tension of finding balance, the managing of trade-offs. And all of this very rarely produces a public testimony sheet of all support. And it made me think, you know, a roomful of an entrepreneurs and a roomful of people that really want to get the job done, this is what it looks like. So congratulations.

CHAIRPERSON NICHOLS: Okay. With that, did you properly close the record or did I never do that? Well, I should have.

The record is closed for this agenda item, but again, it's going to be reopened when the 15-day notice of public availability is issued.

So once again, we will not be receiving comments after today on this item. But after the 15-day notice there will be an opportunity for comment on the 15-day notice items. And they will be responded to in the Final Statement of Reasons for the regulation, which will also

come back to the Board. And we're planning on doing these again in tandem so this rule accompanies the low carbon fuel standard rule and that will keep everything neat. So we have a before us resolution Number 15-5. And do I have a motion?

BOARD MEMBER BERG: So moved.

BOARD MEMBER SHERRIFFS: So moved.

BOARD MEMBER RIORDAN: A second.

CHAIRPERSON NICHOLS: A second, Mrs. Riordan.

All in favor, please say aye.

(Unanimous aye vote)

(Dr. Balmes not present at vote)

CHAIRPERSON NICHOLS: Any opposed? Any abstentions? Okay. Great. Good work.

This really is a culmination of a lot of work, but it isn't over. There's more still to be done. But we're well on our way. So thanks to all. Before we can adjourn, we do have to make time for any public comment. There's no general public comment today. All right. Then we are adjourned.

BOARD MEMBER GIOIA: Chair Nichols, I certainly would be remiss given the team of today's hearing thanking Mr. Corey on several accounts. I want to add to that at the previous meeting last month staff gave a very detailed presentation on our 2015 priorities which I think we all

appreciated.

I made the comment after the presentation and I think it was some public testimony that it would be nice to see some accounting of what we are doing to advance environmental justice kind of cross-pollinated across all the programs and rulemakings and the policies that deal with the Air resources Board. I just wanted to thank them because I'm in receipt of a slide he took it very seriously and sent me a slide doing exactly what I had suggested.

So I wanted to thank you, Richard, for doing that and I think it demonstrates how serious not just Richard but all of our staff take that particular aspect of what we do here.

BOARD MEMBER GIOIA: Can you send that slide to all of us, Richard?

EXECUTIVE OFFICER COREY: Will do. It will be posted as well.

CHAIRPERSON NICHOLS: Oh, good. Everybody will be able to take advantage of it. Thank you all. Safe travel.

(Whereupon the Air Resources Board adjourned at 4:06 p.m.)

CERTIFICATE OF REPORTER

I, TIFFANY C. KRAFT, a Certified Shorthand Reporter of the State of California, and Registered Professional Reporter, do hereby certify:

That I am a disinterested person herein; that the foregoing hearing was reported in shorthand by me, Tiffany C. Kraft, a Certified Shorthand Reporter of the State of California, and thereafter transcribed into typewriting.

I further certify that I am not of counsel or attorney for any of the parties to said hearing nor in any way interested in the outcome of said hearing.

IN WITNESS WHEREOF, I have hereunto set my hand this 4th day of March, 2015.

TIFFANY C. KRAFT, CSR, RPR
Certified Shorthand Reporter
License No. 1227

1_T_ADF_SCAQMD

260. Comment: **ADF T1-1**
The comment urges the Board to approve the ADF proposal and compliments ARB staff on being willing to work with stakeholders on issues related to the proposal.

Agency Response:
ARB staff appreciates the comment in support of the ADF proposal.

2_T_ADF_NLB

261. Comment: **ADF T2-1**
The comment acknowledges that the ADF proposal is a compromise for all sides but that the proposal includes flexibility to permit industry to adapt to necessary changes.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF regulation. ARB staff continues to work with industry to help implement this regulation, whether through the use of certification options, or by other logistical means as stated in the comment.

3_T_ADF_CBA

262. Comment: **ADF T3-1**
The comment shows support for the exemption of fleets composed of 90 percent or more NTDEs as well as other flexibility measures built into the ADF regulation.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF regulation.

263. Comment: **ADF T3-2**
The comment supports the adoption of the ADF regulation.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF regulation.

4_T_ADF_NBB

264. Comment: **ADF T4-1**
The comment states that the ADF proposal will provide a framework that will stabilize the amount of risk a company takes on when it invests in alternative diesel fuels technologies.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF regulation.

265. Comment: **ADF T4-2**
The comment indicates that ARB did an incredible job and appreciates the staff's devotion to ARB's goal of protecting public health.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF regulation.

5_T_ADF_BSB

266. Comment: **ADF T5-1**
The comment states that the ADF proposal reflects necessary compromise and is a well-crafted decision.

Agency Response:
ARB staff appreciates the commentary in support of adopting the ADF regulation.

267. Comment: **ADF T5-2**
The comment reiterates that biodiesel reduces air toxics, in addition to criteria pollutants, and is the only fuel that has been tested successfully with the U.S. EPA.

Agency Response:
ARB staff appreciates the comment and would like to note that biodiesel does reduce PM, which is a criteria pollutant.

268. Comment: **ADF T5-3**
The comment states that they whole heartedly support the ADF program.

Agency Response: ARB staff appreciates the commentary in support of adopting the ADF regulation.

6_T_ADF_Gershen

269. Comment: **ADF T6-1**
The comment expresses appreciation for staff's willingness to work with industry to help provide a variety of compliance options.

Agency Response:
ARB staff appreciates the commentary in support of adopting the ADF regulation.

270. Comment: **ADF T6-2**
The comment expresses confidence and willingness to continue to work with ARB to lower emissions further in the future.

Agency Response:
ARB staff appreciates the commentary in support of adopting the ADF regulation.

7_T_ADF_CF

271. Comment: **ADF T7-1**
The comment points out that the commercial success of biodiesel can account for the success of the ADF rulemaking.

Agency Response:
ARB staff appreciates the comment in support of adopting the ADF proposal.

272. Comment: **ADF T7-2**
The comment attributes many benefits to biodiesel use.

Agency Response:
ARB staff appreciates the comment in support of biodiesel use.

273. Comment: **ADF T7-3**
The comment states that staff should work hard to sunset this regulation as soon as possible.

Agency Response:
ARB staff will work to ensure that the analysis required for the sunset provisions is done in a timely and complete manner. Please refer to comments **ADF 7-1**, in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations," and **ADF 13-16** in this document, for a more detailed response on the sunset timeline.

8_T_ADF_CRE

274. Comment: **ADF T8-1**
The comment states that the ADF proposal allows significant health and carbon reduction benefits while also reconciling the issues to safeguard air quality in terms of NOx emissions.

Agency Response:
ARB staff appreciates the comment in support of the ADF regulation. As stated in the Staff Report the availability of both renewable diesel and biodiesel will help fulfill California's climate goals, provide fuel diversity, and contribute PM emissions reduction benefits while preventing degradation of air quality from current levels.

9_T_ADF_ALAC

275. Comment: **ADF T9-1 and ADF T9-2 EA**

Agency Response: The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

10_T_ADF_CCA

276. Comment: **ADF 10-1**
The comment proclaims that alternative fuels will assist the California community in reducing its reliance on petroleum.

Agency Response:
ARB staff appreciates the comment.

277. Comment: **ADF 10-2**
The comment states that the ADF proposal is well balanced, and allows the use of biodiesel while protecting air quality.

Agency Response:
ARB staff appreciates the commentary in support of adopting the ADF regulation.

11_T_ADF_Neste

278. Comment: **ADF T11-1**
The comment suggests changing the renewable diesel term used in the ADF proposal to renewable hydrocarbon diesel.

Agency Response:
The comment has been addressed in the 15-day changes. Both the LCFS and ADF regulations now refer to “Renewable Hydrocarbon Diesel” rather than “Renewable Diesel” under definitions and define the fuel by its properties and qualities rather than defining it by what it is not as the commenter mentions.

12_T_ADF_REG

279. Comment: **ADF T12-1**
The comment states support for the ADF proposal.

Agency Response:
ARB staff appreciates the commentary in support of adopting the ADF regulation.

13_T_ADF_NRDC

280. Comment: **ADF T13-1**
The comment states that the ADF proposal is reasonable and that supporting the LCFS and ADF programs together maximizes the public health benefits.

Agency Response:
ARB staff appreciates the commentary in support of adopting the ADF regulation.

14_T_ADF_DTF

281. Comment: **ADF T14-1**
The comment states that ARB is engaging in a precedent-setting policy that emission control systems for diesel engines can be used for NOx mitigation after 2018.

Agency Response:
The ADF regulation does not require the use of vehicle hardware in any way. Rather, it accounts for the anticipated increase in a specific technology due to other regulations. The technology used in new technology diesel engines (Selective catalytic reduction or SCR) results in no difference in NOx emissions between biodiesel and conventional diesel up to B20. As such, when vehicle miles travelled by the engines using this technology reach a tipping point, the in-use specifications are no longer necessary for biodiesel. ARB staff sees this as evaluating representative engines and expected use trends rather than using the engine as a strategy. For a discussion of NOx controls sunset, please see **ADF 13-16** in this document and response **ADF 7-1,** in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

282. Comment: **ADF T14-2**
The comment states that the ADF proposal sets a precedent that hardware can be used to mitigate NOx from a fuel.

Agency Response:
Please see response **ADF T14-1**.

D. COMMENTS SUBMITTED DURING THE 15-DAY COMMENT PERIOD

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Comment letter code: 1_F_ADF_WSPA

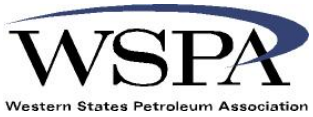
Commenter: Cathy Reheis-Boyd

Affiliation: Western States Petroleum Assoc.

The following letter was submitted to the ADF Docket during the 15-day comment period.

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1_F_ADF
_WSPA



Western States Petroleum Association
Credible Solutions • Responsive Service • Since 1907

Catherine H. Reheis-Boyd
President

June 5, 2015

Clerk of the Board, Air Resources Board
1001 I Street,
Sacramento, CA 95814

Submitted via web: http://www.arb.ca.gov/regact/2015/adf2015/adf15dayregchanges.pdf

Re: **Public Hearing to Consider the Proposed Regulation on the Commercialization of Alternative Diesel Fuels**

The Western States Petroleum Association (WSPA) appreciates the opportunity to submit written comments for the record on the above proposed rulemaking. WSPA is a non-profit trade association representing twenty-five companies that explore for, produce, refine, transport and market petroleum, petroleum products, natural gas and other energy supplies in California, and four other western states.

We understand that at the July 23/24 Board Hearing, the Board will consider final re-adoption of the Low Carbon Fuel Standard (LCFS) Regulation as well as adoption of the Alternative Diesel Fuel (ADF) Regulation. We also understand that staff has jointly progressed these two rulemakings and considers them intimately connected as a joint regulatory action "package" to address Court requirements emanating from the July 15, 2013 State of California Court of Appeal, Fifth Appellate District (Court) opinion in POET LLC versus California Air Resources Board (2013) 218 Ca.App4th661. The judge's opinion was that CARB did not adequately address biodiesel NOx emissions that could potentially result from LCFS implementation. The ADF regulation represents staff's proposed solution to address California Environmental Quality Act deficiencies associated with biodiesel NOx impacts. WSPA provided separate comments on the two concurrent rulemakings for the February 19, 2015 Board Hearing and will provide separate comments on staff's proposed modifications to each of the two regulations prior to the July 23/24 Board Hearing by their respective deadlines for public comment. We regret the unavoidable overlap that is likely to be in our respective comment submissions.

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Our comments below represent WSPA's input to staff's proposed modifications to the ADF regulation presented to the Board on February 19. At that Hearing, the Board directed the Executive Officer to determine if additional conforming modifications to the regulation were appropriate and to make any proposed modified regulatory language available for public comment, with any additional supporting documents and information, for a period of at least 15 days in accordance with Government Code 11346.8. Staff released their proposed modifications to the ADF Rule on May 22, 2015 in what will be referred in the balance of our comments as the "ADF 15-Day Package."

WSPA has worked with ARB over the past few years on the ADF regulation and previously commented that staff's approach in the proposed regulation is the best based on the large number of issues and considerations. Based on the absence of controversial issues (by any of the participating stakeholders) remaining following the Board's initial consideration of the proposed ADF rule on February 19 and subsequent staff workshop on items under consideration for inclusion in the 15-Day package, we expected staff's revisions to be largely non-substantive, i.e., focusing on minor technical and administrative "clean-up" issues. This is true for most of the proposed modifications contained in the ADF 15-Day Package and WSPA is providing limited comments on those revisions. However, we find that the proposed revisions in the ADF 15-Day package include several significant changes that will impact the regulation's effectiveness in limiting NOx emissions from biodiesel blends, and have the potential to substantially increase the compliance burden for our industry which, in fact, may be hard-pressed to accommodate staff's apparent intent to track biodiesel down to each individual sale of a biodiesel blend at retail. WSPA is also concerned with staff's "Additional Analysis to be Added to the Record" in that staff's calculation of the overall NOx impact of the regulation reflects a revised set of assumptions regarding the distribution and use of Renewable Diesel (RD) in the state that are based on limited short-term data that are inconsistent with historical fuel distribution practices in the state, and thus, should not be relied upon as representative of future expectations.

ADF F1-1

ADF F1-2

We are prepared to work with staff as implementation issues arise in the coming years.

Sincerely,



Key Points / Highlights

WSPA supports practical compliance solutions that are tied to commercially proven and available technology, are consistent, and are readily verifiable. As such we oppose:

- Any proposal, such as the one incorporated in the newly introduced limited producer/importer exemption that calls for fuel suppliers to offer unmitigated NOx biodiesel on a regional basis, which has the potential to increase NOx emissions.
- Any proposal that calls for fuel suppliers to monitor fuel use in conjunction with exemptions in order to ensure volumetric or regional restrictions of such exemptions are met (i.e., How can a fuel supplier ensure where a fuel will be used once it is sold?)
- The use of additives at levels not currently recommended by SAE (Society of Automotive Engineers) or engine manufacturers or thoroughly vetted through the Multimedia Evaluation process.

ADF F1-3

WSPA's key comments are summarized below. More detailed discussion on individual sub-topics is provided in the balance of our submission.

- Multi Media Evaluation Reports

  The Biodiesel Multimedia Working Group's recommendations include a provision/condition that fuel formulations and additives that were not included within the scope of this multimedia evaluation must be reviewed by the MMWG for consideration of appropriate action. Similarly, knowledge gaps associated with environmental impacts of additives used in biodiesel are essentially the only meaningful concern indicated by the Working Group which apparently had no clear understanding of what additives may be used in biodiesel and whether the types, concentrations and use specifications differed substantially from those employed in conventional diesel.

  The significance of these caveats involving the use of additives in the MME reports is particularly noteworthy for WSPA members who have previously pointed out to CARB staff that a thorough assessment of DTBP (di-tert-butyl- peroxide), the NOx reduction additive that staff has included as a NOx mitigation measure in the proposed ADF regulation, has yet to be conducted. While air emissions impacts were considered for the use of DTBP, there is no documentation in the MME that other potential impacts of DTBP were evaluated, including, but not limited to:

  - Full multimedia evaluation of environmental impacts (e.g. fate and transport and non-combustion air emissions),
  - Toxicological impacts,
  - Safety impacts (e.g. peroxide stability and interactions with other additives such as anti-oxidants), and,
  - Materials compatibility impacts (e.g. OEM approval, metallurgical compatibility in distribution storage, piping, and fueling equipment).

  ADF F1-4

  We include by reference herein, our comments on this issue submitted as part of the 45-day package. We note that the State Water Resources Control Board's (SWRCB) review was limited

  ADF F1-5

to the differences between biodiesel and CARB diesel[1]. In addition, the Department of Toxic Substance Control (DTSC) performed fate and transform studies with biodiesel, CARB diesel, and biodiesel blends, and with two additives (a biocide and antioxidant). However, they did not test a biodiesel blend with DTBP. The DTSC also noted: "If new or different additives from those tested are proposed for use, appropriate evaluation through the MMWG process should occur."

While DTBP is clearly being proposed for use, it does not appear that either a SWRCB or DTSC review of biodiesel blends containing DTBP was performed as part of the MME. Both agencies clearly indicated that newly proposed additives would need further evaluation, but there is no discussion in the MME as to why DTBP was not included in their reviews.

ADF F1-5 cont

Review of the MMWG response to Peer Review comments, indicate that the SWRCB evaluation assumed that the additives used in biodiesel and biodiesel blends will employ the same additives currently used in CARB diesel, and recommended that other additives used be evaluated separately by the MMWG[2]. As stated in our previous comments, DTBP (as proposed by staff) will be used for a purpose other than the one it was originally intended for (which was cetane enhancement) and at levels (0.25-1.00 volume percent) substantially higher than the range that it is typically used for cetane enhancement (0.1-0.3 volume percent – SAE Technical Series Paper No. 982574). The DTSC's response to Peer Review comments indicate that it is important to understand the real life fate and transport behaviors associated with additive packages relevant to biodiesel/CARB diesel blends.[3] We once again request that ARB fully re-examine the use of DTBP as proposed, to ensure the MMWG examines all potential impacts associated with its use, and feel this request is consistent with the recommendations included in the MME.

ADF F1-6

- Definitions (Par 2293.2)
  - B5 and B20 - The "B" designation normally means the volume of biodiesel blended, not a range of contents. We would prefer that the "B" definition be defined as ranges (e.g. B0 to B5 & B6 to B20). For example, in the current language biodiesel containing slightly over 5% biodiesel would be designated as B20.

ADF F1-7

  - "Renewable Hydrocarbon Diesel"- we would prefer that the definition includes a reference either to the definition of "Hydrocarbon" or includes the wording "elemental composition primarily of hydrogen and carbon" in the definition. We also have concerns with the definition indicating that a fuel additive may be defined as "Renewable Hydrocarbon Diesel" as currently written.

ADF F1-8

  - New Technology Diesel Engine (NTDE) – The definition should be left broad enough to allow for NOx control technologies beyond selective catalytic reduction. We do not believe that staff wants to limit DECS technology to SCR technology for NOx control as other NOx reduction technologies may be developed in the future.

ADF F1-9

[1] 2015 Biodiesel MME (Page 12, Section B).
[2] 2015 Biodiesel MME (Appendix J, Page 31, Response to Comment E-9).
[3] 2015 Biodiesel MME (Appendix J, Page 23, Response to Comment D-1).

- Phase-In Requirements (Par. 2293.5)

  - On Par 2293.5(a)(1)(I): We ask that staff consider including flash point and conductivity (for safety considerations), as well as cetane number or derived cetane number (for performance considerations). We would prefer that ARB reference the appropriate test methods for properties as part of the regulatory language. **ADF F1-10**

  - On Par 2293.5(a)(1)(K): Staff should consider consulting with vehicle manufacturers for a "take no exception" statement to address compatibility concerns, if ADF is being considered as a neat fuel. **ADF F1-11**

  - On Par 2293.5(b)(3)(C): Staff should clarify that the statement "The Executive Officer shall disapprove a proposed pilot program" refers to a Stage 2 pilot program. **ADF F1-12**

  - On Par 2293.5(b)(5): WSPA supports the proposed staff addition to require all applicants with an approved Stage 2 Executive Order to conduct a Multimedia evaluation of the ADF that complies with Health and Safety Code Section 43830.8, including Tier I-III reports (as necessary) and any additional information that the Executive Officer may require to address comments/concerns raised by the Multimedia Working Group or the California Environmental Policy Council. **ADF F1-13**

  - On Par 2293.5(c)(1) and 2293.5(d): WSPA understands that, if additional offsetting strategies/mitigations are required an ADF/ADF blend falls under Stage 3A and, if no such controls are required, it may be designated under Stage 3B. As such the "when considering offsetting factors" language in Paragraph 2293.5(c)(1) appears unnecessary and could be struck. **ADF F1-14**

- In Use Requirements for Specific ADFs Subject to Stage 3A (Par. 2293.6)

  - WSPA supports staff's proposed modification to allow the use of two additional analytical test methods (ASTM D7170-14 and ASTM D7668-14a) for the determination of biodiesel cetane number. **ADF F1-15**

  - WSPA believes that additional definition is required in defining the specific timetable associated with the sunset of biodiesel in-use requirements. We understand the "trigger" is vehicle miles travelled (VMT) by New Technology Diesel Engines (NTDE) reaching 90%. We also understand the new language in the ADF 15-Day package indicating the need for an Executive Order as an official signal that the in-use requirements are no longer in force. However, there is no indication as to how frequently staff will be examining the most recent NTDE market penetration data (WSPA suggest annually), or by when should that examination be completed (WSPA suggests by the end of the first quarter of the following year, i.e., March 31), or how quickly the Executive Officer should issue the sunset order once the threshold is met (WSPA recommends 30 days after the annual assessment is completed, i.e., by April 30 of the following year). **ADF F1-16**

- The Fleet Exemption outlined in Par. 2293.6(5)(A) provides no specific procedures or protocols for facilities to include misfueling of vehicles. In WSPA's view this provides excessive latitude for fleet operators and increases the potential likelihood for abuses of the latitude afforded by this exemption. If both vehicles covered under the exemption as well as legacy vehicles not covered under the exemption are to be refueled at the same facility, staff needs to specify more concrete, robust and enforceable measures to prevent misfueling. It is questionable in our opinion whether this can be effectively accomplished without significant incremental effort by the Fleet operator (i.e., a simple pump label will not do) that the proposed exemption language does not provide in any way. **ADF F1-17**

- The Limited Producer/Importer Exemption outlined in Par. 2293.6(5)(C) is problematic as presented and WSPA is opposed to this exemption. We understand that it is limited to producer/importers that were already blending B6-B20 in 2014 (at least 750,000 gallons that year) and that the volume they will be able to blend in the future is capped at the level they blended in 2014. But the exemption includes no requirement for 90% of the fleet utilizing the fuel covered by the exemption to be light or medium duty vehicles or NTDE heavy duty vehicles. Staff has attempted to protect the South Coast and San Joaquin Valley but it is difficult for one to envision how the restriction of use in those areas could possibly be enforced. Only an attestation of the owner or operator of each fleet that buys the exempted fuel is required and nothing more. The producer/importer is somehow expected to obtain the records of use from their customers and keep track of volumes to ensure annual caps are not exceeded. We can only wonder how they are to do that without real time access to their customers' records and what the recourse would be, if after the end of the year, they discover that their customers sold more of the exempted fuel than they should have. This change is not trivial and arguably lies outside the scope of the type of revision to be included in the ADF 15-Day Package. While staff may argue that the volume cap limits to 2014 levels provides some degree of protection to limit the attendant NOx increase, the fact remains that this new exemption may allow uncontrolled biodiesel to be used in unknown volumes which, coupled with the lack of enforceability, could result in an adverse NOx impact that is difficult to estimate but could be significant. Our comments on staff's treatment of the additional air quality impacts can be found in the discussion of the "Additional Analysis to be Added to the Record" that can be found below. **ADF F1-18**

  We believe that the Developmental Fuel Waivers for Biodiesel should be eliminated now that it is a Stage 3A fuel and request that staff clarify their position on this issue. **ADF F1-19**

- Par. 2293.6(a)(6) highlights staff's proposal to conduct a biodiesel review of in-use requirements on or before 12/31/2019. While WSPA does not have access to the corresponding program review schedule and timetable of the LCFS regulation (staff has not released the LCFS 15-Day package at the time these ADF 15-Day Package comments are being prepared), we recommend that the number of and timetable for interim and/or full program reviews for ADF and LCFS are fully aligned given the close integration between these regulations. **ADF F1-20**

- Specifications for Alternative Diesel Fuels (Par. 2293.7)

  The definition section of the rule defines Biodiesel as meeting ASTM D6751. However, this section also outlines specifications for Biodiesel in Table A.3 which is redundant information. We would prefer that Par. 2293.7 just reference D6751. ADF F1-21

- Reporting and Recordkeeping (Par. 2293.8)

  - 2293.8(b)(2)(B)(4): This section requires more reporting by importers than is necessary for the program. Given that NOx control is not required for biodiesel blends up to B5, the reporting requirement should be limited to be B6-B20 blends. ADF F1-22

  - 2293.8(b)(2)(C): Reporting monthly volumes adds unnecessary complexity to reporting requirements without increasing the quality of information. We recommend reporting quarterly volumes rather than monthly. This simplifies reporting requirements and reduces the total volume of data ARB must review. This approach is also consistent with the structure of reporting for the LCFS. Furthermore, reporting could be further simplified by limiting reporting to those volumes in excess of specified control levels rather than reporting all ADF volumes. ADF F1-23

  - 2293.8(b)(3)(C-D): There are two specific references to "statement on the invoices" in these paragraphs. This contrasts with normal requirements to include statements on "product transfer documents," allowing regulated parties the flexibility of choosing the most efficient means of communicating the required information. We request that these two paragraphs be changed to refer to "statement on product transfer documents." ADF F1-24

  - 2293.8(b)(3)(E)(1): This paragraph requires retailers to maintain records of the carbon intensity of fuel sold. This is not information that is currently tracked all the way to the retail level. Fungible fuels having different carbon intensities are co-mingled in terminal tanks as well as other points in the supply chain upstream of the terminal. It is therefore impractical to require the tracking of carbon intensity all the way to the retail site. This is not required under the LCFS and would involve significant added complexity and recordkeeping and documentation. The carbon intensity of the fuel in question also has no practical application to the ADF program, given that carbon intensity is not an indicator of blending level allowed or NOx control required. Including this provision in the final regulations would add a significant level of complexity to the data tracking requirements throughout the supply chain solely to meet these recordkeeping requirements, which have no apparent purpose under the ADF program. ADF F1-25

- Appendix 1 of Subarticle 2: In Use Requirements for Pollutant Emissions Control

  In revising the requirements for certification testing of ADFs or ADF blends resulting in emissions equivalence with CARB Diesel, staff needs to revisit the following provisions for clarification and/or alteration:

Appendix 1 – Table A.7 - We would prefer to replace Table A.7 with reference to ASTM D7467 Table 1 properties as the candidate fuel property reporting requirement. ADF F1-26

In Appendix A – Table A.8, the fuel specification for "unadditized cetane number" should be updated to be consistent with the regulatory language (cetane number less than or equal to 56 for Low Saturation Level Biodiesel). ADF F1-27

In Appendix 1(a)(2)(B)(1) - The candidate fuel requirements are unclear. It seems that, if the applicant is attempting to certify a candidate fuel blend such as biodiesel with a "heightened fuel specification" or biodiesel produced utilizing a specified production technology, the candidate fuel blend shall consist of a 20% percent blend of the fuel blendstock with CARB Diesel. Staff should clarify what is meant by "heightened fuel specification" as this terminology is not defined elsewhere in the proposed regulation nor employed anywhere else where the meaning can be inferred. Regardless, it is unclear to us why a 10% blend of the fuel blendstock could not be tested and a 20% blend must be employed. Lastly, the use of "CARB Diesel" is confusing given the change in definition of CARB diesel in Par.2293.2. Does staff really intend to allow the candidate test fuel to include up to 5% biodiesel plus RD plus GTL, etc., as long as the candidate fuel properties outlined in Table A.7 are met? ADF F1-28

WSPA continues to maintain that the proposed ADF regulation should adequately address GTL fuels as a potential NOx reduction option (in addition to DTBP). While CARB has assessed the NOx reduction potential of such fuels in the same studies used to establish the characteristics of RD and although earlier versions of the proposed ADF regulation included treatment of GTL fuels, both the January 2, 2015 ADF ISOR and the ADF 15-Day Package are silent on the rationale behind staff's decision to withdraw specific mention of GTL fuels as potential NOx mitigation options. WSPA believes staff should address this matter, preferably in a separate section under Appendix 1 of Subarticle 2, e.g., by adding a section (b) to this Appendix. In doing so, we believe CARB should specify GTL fuel parameters needed for qualification as a NOx mitigation option (e.g., cetane number, aromatics content, PAH content, API gravity), and indicate the minimum volumetric ratio of GTL to biodiesel necessary for mitigation (4 vol/vol). ADF F1-29

- <u>Additional Analysis to be Added to the Record</u>

As staff's summary of revisions included in the ADF 15-Day Package indicates, additional air quality analyses were performed in response to:

- Updated volumes in the LCFS illustrative compliance scenario
- The previously referenced new producer/importer exemption added in Par. 2293.6(a)(5)(C), and
- Re-analysis of certain assumptions involving the method of introduction and distribution of RD in the market through 2023.

In staff's opinion, the combined impact of these does not change "the significance determinations in the draft Environmental Analysis that was prepared for the proposed ADF and LCFS regulations" that the Board considered in the February 19th Hearing. The NOx ADF F1-30

increase from Biodiesel shown for each year (2015-2023) in Table 1: Updated ADF NOx Analyses is invariably lower than the corresponding figures that were reported in the ISOR, Appendix B, Table B1.

In essence, staff added an exemption that directionally increases NOx. Its impact is not reported as a separate line item but is presumably small enough to be more than compensated by the change in the assumed pathway of RD into the market. In the ISOR, staff had assumed that 40% of RD would be imported into the refineries where it would be used to blend CARB diesel and, thus, no credit would accrue for that RD volume to offset biodiesel NOx increases. In the 15-Day package, staff has essentially fixed the annual volume of RD going to the refineries (at 48 million gallons per year - MMGY) through 2023. As the total volume of RD into the state grows to 300 MMGY in 2017, 400 MMGY in 2020 and 600 MMGY in 2023, the volume of RD into refineries stays at 48 MMGY. On a percentage basis, staff's assumption in the 15 Day package means that 16% of the total RD volume into CA will go into refineries in 2017, 12% in 2020 and 8% in 2023.

Clearly the availability of this incremental RD volume provides ample NOx reductions (in staff's calculations) to offset any projected NOx increase from biodiesel or the exemptions provided. But the basis behind the change in staff's assumptions is flawed and fails to recognize the logistical features and limits of the state's fuel distribution system. Staff examined 2014 LRT data and found that only 5% of the RD volume that came into California in 2014 was purchased by refiners with LCFS obligation. Staff interpreted this to mean that refiners are still using RD as a diesel blendstock but no longer purchasing the fuel with obligation. Staff also highlighted an increase in the use of unblended RD (R100) by end users, either through fleet purchase or through retail sales.

ADF F1-30 cont.

While the 2014 breakdowns that staff relied upon can be assumed to be correct, the reliance on data from 2014 to predict the outlook through 2023 is ill-advised. This is because 2014 was a year where all stakeholders were essentially "on hold," waiting to see how the LCFS regulation would evolve as part of the re-adoption process. The relatively modest required 1% CI reduction target required for 2014 apparently did not provide sufficient incentive for refiners to insist on transfers of RD "with obligation" into their facilities. LCFS credit markets were slow, practically illiquid. According to staff's own projections and statements through the workshops leading to February 19, this will all change once the LCFS regulation is re-adopted. There is no reason to believe that the volume of RD received in refineries (with obligation) will not track with the total volume of RD receipts into the state. It is difficult to imagine how the state's infrastructure can accommodate 250-550 MMGY of RD entering the diesel pool downstream of the refineries, while also handling another 160-185 MMGY of biodiesel at the same time. It would be worthwhile for staff to double check their assumptions in this regard with CEC staff who may be better able to advise on appropriate distribution of volumes of RD entering the system.

WSPA requests that staff present stand-alone analysis of the impact of the newly proposed producer/importer exemption, i.e., using the actual 2014 data but the 2015+ biodiesel and RD projections and distribution system breakdowns employed in the ISOR. WSPA would also like to see staff perform sensitivity analyses to develop the net NOx impact for 2015-2023 as the percentage of RD received into CA refineries is increased between 20% and 80% of the total RD volume. WSPA also requests that staff perform sensitivity analysis to develop the net NOx

impact for 2015-2023 if the total volumes of RD into the state fall short of staff's projections and are closer to those predicted by the BCG analyses.

ADF F1-30 cont.

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284. Comment: **ADF F1-1 through ADF F1-6, ADF F1-18, ADF F1-29, and ADF F1-30**

Agency Response:
The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

285. Comment: **ADF F1-7**
The comment states that the "B" designation should be defined as ranges (e.g., B5 is B0 to B5). B5 and B20 are defined in ranges in the regulation in section 2293.2.

Agency Response:
The regulation is already consistent with the suggestion. B5 is defined as "a biodiesel blend containing no more than five percent biodiesel by volume." B20 is defined as biodiesel blend containing more than five and no more than 20 percent biodiesel by volume. By definition and by industry convention, biodiesel containing over five percent and no more than 20 percent biodiesel is designated as B20; in-use requirements will be applicable accordingly.

286. Comment: **ADF F1-8**
The comment states that the "Renewable Hydrocarbon Diesel" definition should include a reference either to the definition of "Hydrocarbon" or includes the wording "elemental composition primarily of hydrogen and carbon" in the definition. The comment goes on to express concern that additives may be considered Renewable Hydrocarbon Diesel per the definition.

Agency Response:
In response to the 45-day public comment, the ADF regulation includes a revised definition of 'Hydrocarbon' in section 2293.2. It is defined as "any homogeneous mixture with elemental composition primarily of hydrogen and carbon that may contain residual impurities." The revised definition is consistent with the suggested revision.

Furthermore, the use of the word "additive" in this definition is related to fuel components that may be blended with diesel. For example, in a mixture of two blended fuels, the fuel with lower blend-level may be considered an additive. The current definition does not expand the scope of Renewable Hydrocarbon Diesel to include other additives that are not fuel blend components.

287. Comment: **ADF F1-9**
The comment states that the definition of New Technology Diesel Engine (NTDE) should be left broad enough to allow for NOx control technologies beyond selective catalytic reduction (SCR) and not to limit Diesel Emission Control Strategy technology to SCR as other technologies may be developed in the future.

Agency Response:
SCR technology is currently the only known exhaust after-treatment technology that does not experience NOx emissions increases from biodiesel use. When other NOx-mitigating technologies become available for biodiesel, staff will consider expanding the NTDE definition.

288. Comment: **ADF F1-10**
The comment suggests that staff consider requiring submission of additional fuel properties as part of Stage 1, for safety reasons. Additionally, the comment requests that ARB staff reference appropriate test methods in the regulatory language.

Agency Response:
Section 2293.5(a)(1)(J) of the ADF regulation, requires submission of a Material Safety Data Sheet (MSDS); many safety related properties often available on the MSDS, including the flash point of the fuel. Any safety and performance requirements are expected to be included during the development of Stage 2 fuel specification process. Staff has made every effort to ensure that appropriate test methods are specified in the regulation. Additionally, the CDFA and ASTM will address safety and performance issues for emerging ADFs.

289. Comment: **ADF F1-11**
The comment requests that the regulation require consultation with vehicle manufacturers as part of Stage 1.

Agency Response:
Stage 1 volumes cannot exceed 1 million gallons of diesel fuel per year per ADF and the applicant must have an attestation that the vehicles used in the pilot program are either owned by the applicant or the applicant has received written consent from the owner. During Stage 1 it is expected that the engine or vehicle operators will take whatever precautionary steps they feel is necessary to ensure fuel compatibility, warranty, or any other performance concerns. The regulation currently requires engine manufacturer consultation as part of Stage 2.

290. Comment: **ADF F1-12**
The comment suggests that staff clarify the statement in section 2293.5(b)(3)(C); "The Executive Officer shall disapprove a proposed pilot program" as referring to a Stage 2 pilot program.

Agency Response:
The title of section 2293.5(b) is "Stage 2: Development of Fuel Specification." For this purpose, all of the subsections refer to actions taken under Stage 2.

291. Comment: **ADF F1-13**
The comment is supportive of the multimedia evaluation provisions of the 15-day changes.

Agency Response:
ARB staff appreciates the support for the adoption of the ADF regulation.

292. Comment: **ADF F1-14**
The comment states that language in section 2293.5(c)(1) is unnecessary.

Agency Response:
ARB staff revised the language in 2293.5(c)(1) and believes it is necessary to provide clarity.

293. Comment: **ADF F1-15**
The comment is supportive of additional test methods being allowed in 15-day changes.

Agency Response:
ARB staff appreciates the support for the adoption of the ADF regulation.

294. Comment: **ADF F1-16**
The comment requests additional clarification of the specific timetable and process associated with the sunset of biodiesel in-use requirement.

Agency Response:
Please see responses to comments **ADF 13-16** in this document and **ADF 7-1**, found in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

295. Comment: **ADF F1-17**
The comment requests more robust requirements to prevent misfueling.

Agency Response:
All fuel dispensing pumps must be labeled in accordance with California Business and Professions Code, section 13480(a). This code requires each component of fuel storage and delivery system, including fuel pumps, to be affixed with an easily visible sign or label containing the name of the product. Additionally, in section 2293.5(a), Stage 1 and Stage 2 application, the applicant is required to provide the manner of labeling for distribution pumps, to ensure proper use of the fuel. ARB can also test vehicles covered by the exemption for fuel use, or require additional labeling or other necessary measures to ensure no misfueling occurs. Vehicle manufacturers also provide guidance on appropriate and acceptable fuel use for the vehicles/engines, in the vehicle operation manual. ARB staff believes that adequate labeling designed for the product, as well as the information in the vehicle's operating manual, should be sufficient to eliminate misfueling.

296. Comment: **ADF F1-19**
The comment states that the Developmental Fuel Waivers for biodiesel should be eliminated now that it is a Stage 3A fuel and requests that staff clarify their position on this issue.

Agency Response:
ARB does not issue developmental fuel waivers for biodiesel. Staff assumes that this comment is related to developmental fuel variances allowing sale of fuel that does not meet the specifications established by the California Department of Food and Agriculture. The CDFA variance program is outside the scope of the ADF regulation.

297. Comment: **ADF F1-20**
The comment recommends that the ADF and LCFS program reviews be aligned.

Agency Response:
Please see response to comment **ADF 13-4.**

298. Comment: **ADF F1-21**
The comment recommends that the specification for biodiesel under section 2293.7 simply refer to ASTM D6751.

Agency Response:
Although the cetane specification for biodiesel is included in ASTM D6751, specifications for sulfur and API Gravity are not included. The

cetane specification is listed here as a backstop in case the ASTM standard changes. If the cetane requirement were lowered, it could lead to increased NOx emissions from biodiesel.

299. Comment: **ADF F1-22**
The comment suggests that there is unnecessary reporting for importers in section 2293.8(b)(2)(B)(4).

Agency Response:
This provision was intended to collect blend volumes requiring NOx control. For reporting blends up to B5, it is sufficient to report the blend level since those do not require NOx control. The reporting requirement for importers is similar to the provisions for blenders in California since the biodiesel may be blended prior to import.

300. Comment: **ADF F1-23**
The comment claims that reporting monthly volume adds complexity to the reporting requirements without increasing the quality of information. The comment goes on to request that the reporting requirements exclude blends that are not subject to in-use requirements (e.g., B5).

Agency Response:
Monthly data is necessary because the NOx control dates do not align with quarters.

The provisions requiring reporting of B5 transactions are necessary as they contribute to ARB staff's ability to enforce the provisions by being able to account for all blending of biodiesel.

301. Comment: **ADF F1-24**
The comment notes that in some cases the term product transfer document is used and in others the term transaction invoice is used, and suggests using exclusively product transfer document.

Agency Response:
ARB staff considers the term transaction invoice to be equivalent to product transfer document. Regulated parties should keep product transfer documents as documentation of meeting the recordkeeping requirements

302. Comment: **ADF F1-25**
The comment states that carbon intensity (CI) of the fuel information is not currently tracked all the way to the retail level and also, the CI information has no practical application to the ADF program.

Agency Response:
The intention of this provision was to ensure that those entities who

already have a Carbon Intensity indicated on their product document keep that documentation, as it may prove useful in enforcement. Documents with CI indicated must be kept in accordance with the recordkeeping provisions, otherwise, only the product transfer document must be kept.

303. Comment: **ADF F1-26**
The comment suggests replacing the table of candidate fuel properties (Table 7) in Appendix 1 with ASTM D7467.

Agency Response:
Although many of the properties in table 7 and D7467 overlap, the properties in each are different and they serve different purposes. The properties in ASTM D7467 were chosen due to their impact on fuel quality and performance, while the properties in Table 7 were chosen due to their correlation and importance to emissions.

304. Comment: **ADF F1-27**
The comments suggest that the cetane number for the additive certification blendstock be changed from 47- 50 to below 56.

Agency Response:
Cetane number has been found to correlate with NOx emissions from biodiesel; lower cetane biodiesel tends to have higher NOx emissions. This provision is solely related to testing and certifying the biodiesel additive, as such, the blendstock needs to be representative of the higher emitting biodiesels that may exist in the commercial market. The cetane number for this provision was set at 47-50 to ensure that the tested blendstock would be representative of the higher NOx emitting commercial biodiesels. Additionally, please see response **ADF 3-142**, paragraph 2.

305. Comment: **ADF F1-28**
The comment states that the term “heightened fuel specification” as used in Appendix 1 is confusing, and requests clarification. The comment goes on to request clarification on whether a 10 percent blend of ADF formulation as a candidate fuel may be certified, and if not why not. Finally, the comment requests clarification of the term CARB diesel as used in Appendix 1.

Agency Response:
“Heightened fuel specification” was used to denote any fuel based properties that are different and presumably better or heightened than the minimum fuel specifications in the ADF regulation. For example if one were to produce a biodiesel with minimum cetane number of 62, greater than the 56 cetane number required to be considered high saturation, this may be considered a “heightened fuel specification.”

Candidate ADF formulations must certify at B20. This is to maintain the fungibility of biodiesel blendstocks and blends. Allowing ADF formulations to certify at different levels would potentially introduce different blends that would have to be labeled differently and would need to be stored separately, which staff wanted to avoid.

The use of CARB diesel in this section refers to Reference CARB diesel, or reference fuel, which does not include biodiesel. As stated in the appendix (a)(2)(E) the reference CARB diesel "shall be produced from straight-run California diesel fuel by a hydrodearomatization process and shall have the characteristics set forth below". This means that the fuel must meet both California standards and reference fuel standards, and must be produced using specific refinery processes: this would not include biodiesel.

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Comment letter code: 2_F_ADF_NBB

Commenter: Shelby Neal

Affiliation: National Biodiesel Board

The following letter was submitted to the ADF Docket during the 15-day comment period.

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2_F_ADF
_NBB

June 8, 2015

Mary D. Nichols
Chair
California Air Resources Board
P.O. Box 2815
Sacramento, CA 95814
Submitted via electronic mail.

Re: Written comments from the National Biodiesel Board on proposed Regulations for the Commercialization of Alternative Diesel Fuels.

Dear Chair Nichols:

Thank you for the opportunity to comment on these regulations. We sincerely value the job you and all ARB board members and staff undertake in protecting the state's environment and public health.

By way of background, the National Biodiesel Board (NBB) serves as the trade association for the U.S. biodiesel and renewable diesel industries. The NBB represents more than 90 percent of domestic biodiesel and renewable diesel production. In addition to governmental affairs activities, the association coordinates the industry's research and development efforts.

Before delving briefly into a few key regulatory areas, I would like to express our appreciation to the Air Resources Board (ARB) for the cooperation we have received over the past several years. Biodiesel has encountered unique regulatory challenges as a result of being the first alternative diesel fuel to ascend to commercial scale. I am pleased to report that, in each situation we have encountered, ARB staff have diligently worked through whatever issues presented themselves with great skill, integrity, and professionalism. It has been a pleasure to work with staff on numerous matters of precedent-setting importance.

<u>Renewable Diesel and NOx Emissions from Biomass-Based Diesel Fuels.</u>

The report notes that 40 percent of renewable diesel is currently blended at the refinery level as a "blendstock" used to make finished diesel fuel and therefore should not be counted as an offset to biodiesel emissions. We fail to understand the logic of this position. Whether a California refiner or a downstream wholesaler blends renewable diesel seems irrelevant to us. The salient point is that renewable diesel is being used in California and should be considered as an offset to similar biomass-based diesel fuels such as biodiesel.

ADF F2-1

Limited Producer/Importer Exemption

It appears that the provision is written such that a producer or importer may apply to sell B20 to fleets by January 1, 2017 and that this exemption is in effect for that producer and for only those fleets specified until such time as the Executive Office determines that biodiesel has met the sunset requirements under the regulation. If our reading is correct, we would prefer a provision that allows qualified producers to apply for an exemption annually or every two years, reflecting an updated list of fleet customers. This added flexibility would not impact the efficacy of the provision since the volume limitations would remain in place.

ADF F2-2

Table A.7 and A.8

The distillation method should be changed from ASTM D86 to ASTM D1160. ASTM D86 is appropriate for blends, but not pure biodiesel.

ADF F2-3

The viscosity specification should be increased from 4.1 to 6.0, consistent with the requirements of D6751. Viscosity has not been identified as a property important to biodiesel emissions. Moreover, most biodiesel will display a viscosity level in excess of 4.1.

ADF F2-4

Additive Testing

Page 45 [(G)2] seems to suggest that any additive used to meet the requirements of the program would require testing to ensure the absence of negative emissions impacts. We would like to clarify that this requirement would only pertain to additives that are not already approved for use by the Air Resources Board.

ADF F2-5

Reporting

We suggest allowing producers the flexibility to report the properties of their fuel by either the saturation level of the biodiesel (low or high) or the type of feedstock.

ADF F2-6

Certification of NOx-neutral Biodiesel Blends

We would like to clarify that NOx-neutral blends of biodiesel using an additive may be certified at any blend level, i.e. B10, B15, or B20. The NBB plans to initiate an additive testing certification program, potentially at various blend levels.

ADF F2-7

Thank you, in advance, for your consideration of our views on these important matters. If I may be of any assistance, please feel free to contact me at any time at (573) 635-3893.

Sincerely,



Shelby Neal
Director of State Governmental Affairs

2_F_ADF_NBB

306. Comment: **ADF F2-1**
The comment suggests that the assumption in staff's NOx analysis that renewable diesel used as a blendstock in refineries may not contribute to NOx decreases is incorrect.

Agency Response:
As stated in the ADF 15-day notice "If RD is used in refineries, it may only be offsetting the emissions of a dirtier diesel blendstock and may not be available to offset the NOx emissions of biodiesel downstream. Therefore, to be conservative in estimating potential NOx emissions (i.e., to ensure potential NOx impacts from biodiesel were not underestimated), ARB has reduced the total RD volume expected to provide NOx emissions reductions by the amount that is estimated to be used at refineries as a blendstock." ARB staff has not confirmed that this is definitively the case, but has used this assumption in order to avoid potential double counting of NOx reductions and to be conservative in the environmental analysis. If this assumption were not used, the NOx decreases from renewable diesel would be greater and the overall NOx emissions would be lower. Staff will use the latest available data to examine this assumption as part of the regulation review.

307. Comment: **ADF F2-2**
The comment recommends that application for the limited producer/importer exemption be allowed more frequently than a single time.

Agency Response:
ARB staff introduced this requirement to limit the potential impact of the limited exemption on NOx emissions from biodiesel. No updates are anticipated.

308. Comment: **ADF F2-3**
The comment recommends that the distillation test method specified in the regulation be changed to ASTM D1160.

Agency Response:
The method specified in the regulation is based on the method specified in the diesel certification program under 13 CCR 2282. The regulation includes a provision for use of other test methods if they are found to be equivalent. ARB staff will continue to work to determine the equivalency and the appropriateness of ASTM D1160.

309. Comment: **ADF F2-4**
The comment recommends a change in the viscosity specification for biodiesel blendstock.

Agency Response:
This upper end viscosity requirement is based on the diesel regulation certification provisions under 13 CCR 2282. Staff will consider the viscosity issue when analyzing applications for certification.

310. Comment: **ADF F2-5**
The comment requests clarification of the applicability of the additive testing requirements.

Agency Response:
ARB staff agrees with the comment; accordingly, the requirement applies only to new additives.

311. Comment: **ADF F2-6**
The comment requests letting producers report the properties of their fuel by either the saturation level of the fuel or the feedstock.

Agency Response:
The reporting provision that requires producers to report by feedstock could be satisfied by the saturation level of the feedstock or by the actual type of oil or fat from which the biodiesel was derived.

312. Comment: **ADF F2-7**
The comment requests clarification of whether additive certification can be completed for any blend level of biodiesel.

Agency Response:
Additive certification can be conducted for any blend level.

Comment letter code: 3_F_ADF_CBA

Commenter: Celia DuBose

Affiliation: California Biodiesel Alliance

The following letter was submitted to the ADF Docket during the 15-day comment period.

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3_F_ADF
_CBA

June 5, 2015

Mary D. Nichols
Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95812

RE: **SUPPORT FOR ADF REGULATION ADOPTION**

Dear Chair Nichols:

On behalf of the California Biodiesel Alliance (CBA), I am submitting these comments in support of the adoption of the Alternative Diesel Fuel (ADF) regulation, specifically the *Proposed 15-Day Modification of the Regulation*. As you know, CBA is California's not-for-profit biodiesel industry trade association, representing over 50 businesses and stakeholders, including all of the state's biodiesel producers. As part of a unified industry statement, we support the comments of the National Biodiesel Board.

First, we want to reiterate the thanks, which we and many of our individual members expressed in person at your February 19th public meeting, for the extensive work of California Air Resources Board (ARB) staff over many years to craft a path to full legal status for biodiesel in the state that provides clear guidelines for our industry's growth going forward. We are excited about biodiesel's increasing recognition as a widely available drop-in fuel that is making significant contributions to the state's petroleum, carbon, and particulate matter reduction goals while creating good, family-supporting jobs, many in disadvantaged communities.

In previous comments we expressed appreciation for the framework in the regulation that allows biodiesel to move forward with some time to develop a new NOx mitigation additive; for the exemptions for B20 use in light and medium duty fleets and for those with 90% NTDEs; and for the 2019 review that will provide data on actual vehicle miles traveled as fleets turnover to the use of NTDEs. We also especially value the recent addition of a Limited Producer/Importer Exemption for direct sales of B20 to captive fleets that meet certain conditions.

ADF F3-1

Thank you again for your agency's leadership, and we look forward to working together through the implementation phase of this regulation. Please contact me at 760-398-0815 with any questions.

Sincerely,

Curtis Wright,
Chairman
California Biodiesel Alliance

3_F_ADF_CBA

313. Comment: **ADF F3-1**
The comment supports several provisions in the ADF regulation.

Agency Response:
ARB staff appreciates the support for the adoption of the ADF regulation.

Comment letter code: 4_F_ADF_TEMA

Commenter: Roger Gault

Affiliation: Truck and Engine Manufacturers Assoc.

The following letter was submitted to the ADF Docket during the 15-day comment period.

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_TEMA

STATE OF CALIFORNIA
AIR RESOURCES BOARD

Proposed Regulation on the	**)**	**Agenda Item 15-2-3**
Commercialization of New Alternative	**)**	**Proposed 15-Day Changes**
Diesel Fuels	**)**	**Comment Deadline: June 8, 2015**
	)	

COMMENTS OF THE TRUCK AND ENGINE MANUFACTURERS ASSOCIATION

June 8, 2015

Roger Gault
Truck and Engine Manufacturers Association
333 West Wacker Drive
Chicago, Illinois 60606
(312) 929-1974

STATE OF CALIFORNIA
AIR RESOURCES BOARD

Proposed Regulation on the Commercialization of New Alternative Diesel Fuels	**)** **)** **)** **)**	**Agenda Item 15-2-3** **Proposed 15-Day Changes** **Comment Deadline: June 8, 2015**

COMMENTS OF THE TRUCK AND ENGINE MANUFACTURERS ASSOCIATION

On May 22, 2015, the California Air Resources Board ("ARB") published a "Notice of Public Availability of Modified Test and Availability of Additional Documents. Proposed Regulation on the Commercialization of New Alternative Diesel Fuels" [CCR, Title 13, Chapter 5, Article 3, Sub article 2, Sections 2290, 2291, and 2293] (the "15-Day Changes").

The Truck and Engine Manufacturers Association ("EMA") is the international trade association that represents the interests of the world's leading manufacturers of compression ignition engines used in both on-highway and nonroad products that will utilize the fuels covered by the Proposal.

ARB should make several revisions to the 15-Day Changes prior to its adoption as a Final Rule.

First, EMA recommends that, based on the 15-Day Changes, ARB adopt a definition for "additive" such that fuels approved by ARB under Stage 1, Stage 2, Stage 3A, or Stage 3B per the proposed regulation are not substantially changed through additization. Based on the revised definition of "Hydrocarbon," for example, there is a potential that fuels will not consist of hydrogen and carbon exclusively. ADF F4-1

Second, EMA recommends that ARB consider EMA's original comments, which have not been incorporated into the 15-Day Changes. Specifically, EMA recommends that ARB:

1. Establish, in writing, a process that ARB will utilize to determine that 75% of engine manufacturers have accepted a Stage 2 fuel. ADF F4-2
2. Define the term "consensus standard" in the Final Rule to clarify that, at a minimum, consensus standards required by the regulation are developed by fuel producers, fuel marketers, engine manufacturers, and users. ADF F4-3
3. Clarify that all biodiesel blends greater than B20 are Stage 1 fuels that must meet all the Stage 1 and Stage 2 program requirements prior to determination that Stage 3A or 3B is appropriate for those fuels. ADF F4-4
4. Delete the option to utilize 0.75% percent DTBP additive treatment in B10-B15 biodiesel blends and the option to utilize 1.0 percent DTBP additive treatment in B15 - B20 biodiesel blends with low saturation biodiesel as NOx mitigation measures. ADF F4-5

If you have any questions about EMA's comments, or would like to discuss this matter further, please do not hesitate to contact us.

Respectfully submitted,

Truck and Engine Manufacturers Association

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4_F_ADF_TEMA

314. Comment: **ADF F4-1**
The comment recommends adopting a definition of "additive" to ensure that fuels approved under the three-stage approval process are not substantially changed through additization.

Agency Response:
Staff believes that the approval process, definitions, and exemption for 1 percent or less of additives are both clear and feasible as currently written. Since the exemption for additives only applies for a total of up to one percent of additives, other than those used for emissions reduction, it is unlikely that substantial change to the approved fuels would occur through additization.

315. Comment: **ADF F4-2**
The comment refers to comments originally submitted in the 45-day comment period, and suggests that ARB establish a written process for determining how one meets the 75 percent threshold for engine manufacturer approval.

Agency Response:
Please see response to comment **ADF 1-2**, regarding the 75 percent threshold.

316. Comment: **ADF F4-3**
The comment refers to comments originally submitted in the 45-day comment period, and suggests ARB define consensus standards.

Agency Response: Please see response to comment **ADF 1-3**, regarding the consensus standards.

317. Comment: **ADF F4-4**
The comment refers to comments originally submitted in the 45-day comment period, and suggests that ARB clarify the status of biodiesel blends above B20 regarding the phase in requirements of the ADF regulation.

Agency Response: Please see response to comment **ADF 1-4**

318. Comment: **ADF F4-5**
The comment refers to comments originally submitted in the 45-day comment period, and suggests ARB eliminate the DTBP in-use control options.

Agency Response: ARB does not plan to eliminate the DTBP in-use control options. For more information please see response to comment **ADF 1-6**.

Comment letter code: 5_F_ADF_POET

Commenter: Joshua Willter

Affiliation: POET

The following letter was submitted to the ADF Docket during the 15-day comment period.

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_POET

Additional Analysis Required Under the California Environmental Quality Act, the Administrative Procedures Act, and the Health & Safety Code

On December 30, 2014, CARB circulated for public review an Initial Statement of Reasons (the "ISOR") and an Environmental Analysis ("EA") for CARB's proposed Regulation on the Commercialization of Alternative Diesel Fuels (the "ADF regulation"). Following a February 19, 2015, public hearing on the ADF regulation, the Board directed staff to consider modifications to the ADF regulation, and respond to environmental comments.

CARB released proposed modifications to the ADF regulation through its May 22, 2015, Notice of Public Availability of Modified Text and Availability of Additional Documents (the "15-Day Notice"). According to the 15-Day Notice, the proposed modifications include, among other things, changes to the baselines used for multimedia evaluations, a requirement that environmental risk be evaluated by CARB staff for the pilot program, and an exemption for producers or importers allowing sales of B6 to B20 in areas other than the South Coast or San Joaquin Air basins. The 15-Day Notice does not provide any analysis of these impacts, or evidentiary support, but instead finds they "do not change the significance determinations in the draft Environmental Analysis that was prepared for the proposed ADF and proposed LCFS regulations, and previously circulated for public comment." (*Id.* at 11.)

As a result of these, and other, defects, Growth Energy submits the following comments on the proposed modifications to the ADF regulation under the California Environmental Quality Act, the California Administrative Procedures Act, and the Health & Safety Code.

A. The Information Provided By CARB Is Insufficient to Analyze The Modifications Reflected in the 15-Day Notice

1. The Analyses Supporting the Conclusions Stated in the 15-Day Notice Have Not Been Disclosed, in Violation of CEQA

An EIR – or its functional equivalent, like the EA here – should "include detail sufficient to enable those who did not participate in its preparation to understand and to consider meaningfully the issues raised by the proposed project." (*Laurel Heights Improvement Ass'n v. Regents of Univ. of Calif.* (1988) 47 Cal.3d 376, 405.) CARB is required to make a good faith attempt to find out and disclose all that it reasonably can. (See, e.g., *Vineyard Area Citizens for Responsible Growth v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 428; *Berkeley Keep Jets Over the Bay Comm. v. Bd. of Port Comm'rs* (2001) 91 Cal.App.4th 1344; *Citizens for Preserve the Ojai v. County of Ventura* (1985) 176 Cal.App.3d 421, 431.)

Further, an unsubstantiated conclusion that an impact is not significant, without supporting information or explanatory analysis, is insufficient; the reasoning supporting the determination of insignificance must be disclosed. (*City of Maywood v. Los Angeles Unified School District* (2012) 208 Cal.App.4th 362, 393; *Protect the Historic Amador Waterways v. Amador Water Agency* (2004) 116 Cal.App.4th 1099, 1111; *Citizens to Preserve the Ojai v. County of Ventura* (1985) 176 Cal.App.3d 421, 432.)

CARB violated CEQA by failing to provide this information. The Notice of Public Availability of Modified Text and Availability of Additional Documents (the "15-Day Notice") reveals that the proposed modifications to the ADF regulation (specifically, the producer/exporter exemption) would create "additional air quality impacts," (15-Day Notice at 5), including "NOx increases from biodiesel . . . ." (*Id.* at 11.) The 15-Day Notice also reveals that CARB staff "reduced the total [renewable diesel] volume expected to provide NOx emissions reductions" due to inaccurate assumptions made in the ISOR. (*Id.* at 12.) Despite these admissions, the 15-Day Notice states, "Staff has determined that the combined effects of [the proposed] changes do not change the significance determinations in the draft Environmental Analysis that was prepared for the proposed ADF and proposed LCFS regulations, and previously circulated for public comment." (*Id.* at 11.)

The 15-Day Notice, however, provides no information showing how CARB reached its conclusions regarding the NOx impacts of the proposed modifications, and in particular its bare conclusion that the modifications would not "change the significance determinations" in the draft EA. Nor is there any information showing how CARB quantified the admitted increases in NOx. There is also no information as to what diesel sources are included in CARB's emissions "inventory." As explained in an accompanying declaration prepared by an expert with relevant knowledge of the issues on which the 15-Day Notice touches, due CARB's failure to "provide [such] detailed information," "it was not possible . . . to review the data and assumptions used by CARB," nor was the expert able "to reach a conclusion about the accuracy of the analysis that was purported to have been performed or the conclusions drawn from the analysis by CARB." (Declaration of Lyons ["Decl. Lyons"] ¶ 7.) Because CARB staff has not provided information necessary to evaluate the conclusions in the 15-Day Notice, the EA should be revised and updated to provide this fundamental information, and recirculated for public review and comment.

ADF F5-1

2. The Rulemaking File Continues to Be Incomplete, Frustrating the Public's Attempts to Review CARB's Conclusions

In its comments on the ISOR and the EA for the ADF regulation, Growth Energy informed CARB that it was unable to perform a complete evaluation of the ADF regulation because important information was not included in the rulemaking file.

For example, CARB failed to include the materials required under AB 1085 in the rulemaking file, including information relating to air emissions, health impacts, and economic impacts. An example of a CARB rulemaking that contains this information is

ADF F5-2

located at http://www.arb.ca.gov/msprog/ordiesel/offroad_1085.htm. This information continues to be absent from the rulemaking file.

Because a multimedia evaluation was required as part of the instant rulemaking, the rulemaking file must also include all documents associated with the multimedia evaluation, which have not been made available to the public. Because the multimedia evaluation presumably relies upon some – albeit unspecified – information, the information forming the basis of the conclusions in the evaluation necessarily includes "data and factual information . . . on which the agency is relying." (Govt. Code, § 11347.3, subd. (b)(7).) Further, because CARB is legally required to prepare a multimedia evaluation, the information underlying the analysis in the multimedia evaluation constitutes "information, statement[s], report[s], or data that the agency is required by law to consider or prepare in connection with . . . a regulation." (*Id.*, subd. (b)(11).)

ADF F5-2 cont.

There is likewise no information in the rulemaking file sufficient to explain how CARB staff reached the conclusion that the proposed modifications "do not change the significance determinations in the draft Environmental Analysis that was prepared for the proposed ADF and proposed LCFS regulations, and previously circulated for public comment." (15-Day Notice at 11.) Plainly, such information includes at the very least "data and factual information . . . on which the agency is relying," (Govt. Code, subd. (b)(7)), or the "information, statement, report, or data that the agency is required by law to consider or prepare in connection with . . . a regulation." (*Id.*, subd. (b)(11).)

Because the rulemaking file does not contain all necessary information, CARB has violated Section 11347.3 of the Government Code.[1]

3. CARB's Interpretation of Section 11347.3, Subdivisions (b)(6), (b)(7), and (b)(11) Is Too Narrow

CARB also appears to assert that, to satisfy Section 11347.3, Subdivisions (b)(6), (b)(7), and (b)(11) of the Government Code, CARB need only include in the rulemaking file the four documents specifically mentioned in Paragraph 5 of the Peremptory Writ of Mandate issued in the matter of *POET, LLC v. California Air Resources Board, et al.*, Fresno County Superior Court, Case No. 09-CECG-04659. That is not accurate. Section 11347.4, subdivision (b)(6) requires CARB to include "[a]ll data and other factual information, any studies or reports, and written comments submitted to the agency in connection with the adoption, amendment, or repeal of the regulation." (Govt. Code § 11347.3, subd. (b)(6).) Likewise, subdivision (b)(7) requires the include of "[a]ll data and factual information . . . on which the agency is relying . . . ." (*Id.*, subd. (b)(7).) Further, Subdvision (b)(11) requires the inclusion of "[a]ny other information,

ADF F5-3

[1] Growth Energy notes that the 15-Day Notice for the Low Carbon Fuel Standard released on June 4, 2015, at page 12 references several documents to be included in the rulemaking file that was submitted to CARB by its consultants. It is implausible that similar documents somehow do not exist relating to the 15-Day Notice for the ADF regulation.

ADF F5-2 cont.

statement, report, or data that the agency is required by law to consider or prepare in connection with . . . a regulation." (*Id.*, subd. (b)(11).)

All information required under Subdivisions (b)(6), (b)(7), and (b)(11) must be included, not just the four documents specifically identified in the Peremptory Writ of Mandate.

ADF F5-3 cont.

B. The 15-Day Review Period Provides Insufficient Time for Commenting Parties to Evaluate the Modifications to the Proposed ADF Regulation; CARB Should Recirculate the EA

Fifteen calendar days provides insufficient time for the public to review CARB's modifications to the ADF regulation for several reasons.

First, the 15-Day Notice not only includes substantial modifications to the ADF regulation, but also extensive Multimedia Evaluations for both Biodiesel and Renewable Diesel. These documents total several hundreds of pages, much of which is highly technical data. This review is also being conducted concurrently with the 15-day notice for the related LCFS regulation, with its own short comment period. Fifteen days is insufficient for technical experts with relevant knowledge of the subject matter of the ADF regulation and the 15-Day Notice; certainly, a member of the public with no technical or legal background could not meaningfully be asked to provide comments on CARB's modifications within the timeframe allotted.

ADF F5-4

The prejudice caused by the short review period provided in the 15-Day Notice is exacerbated by the fact that many of the conclusions in the 15-Day Notice regarding the ***recognized*** environmental effects of the ADF regulation have been provided without supporting information or documentation, as explained above. In addition to the fact that the failure to include this analysis violates CEQA, (see *supra*, § A(1)), the failure to include this information makes it nearly impossible to even attempt to reconstruct CARB's analysis within the short amount of time provided.

C. The EA Should Be Revised to Evaluate Potential Increases in NOx Emissions, and Recirculated

CARB should recirculate the EA to provide the public sufficient opportunity to evaluate the new impacts associated with the proposed modifications, as well as significant new information showing the ADF regulation will have greater impacts than previously disclosed.

The 15-Day Notice includes a new exemption for the use of B6 to B20 fuels in older heavy-duty vehicles under Section 2293.6(a)(5)(C) of the ADF regulation. (15-Day Notice at 5.) These fuels, however, generally result in greater NOx emissions, which will increase the negative air quality impacts of the ADF regulations,, as CARB itself concedes. (See 15-Day Notice at 5 [noting the addition of an exemption for certain B6 to B20 sales "could result in additional air quality impacts . . . ."].) The exemption could also create localized increases in NOx emissions outside of the South Coast Air Basin or San

ADF F5-5

Joaquin Valley Air Basin. "Although the South Coast and San Joaquin Valley Air Basins experience the highest ozone levels in the state, there are many other areas in non-attainment of the federal and state standards where increased NOx emissions could create adverse impacts on air quality." (Decl. Lyons ¶ 8; see also *id.* ¶ 9 [showing estimated statement emissions in Table 1 of the 15-Day Notice [0.95 tons per day] is far greater than threshold of significance used by the Sacramento Metropolitan Air Quality Management District [0.0325 tons per day]].) These impacts are not analyzed in either the 15-Day Notice or the EA.

ADF F5-5 cont.

In addition, the new exemptions were not outlined or suggested in any way in the notice of proposed rulemaking and its supporting materials published in December. Because these changes were neither "nonsubstantial" nor sufficiently related to the original notice, they cannot be adopted by way of a 15-day notice. (Govt. Code § 11346.8, subd. (c); 1 Cal. Code Regs. § 40, 42; see also Decl. Lyons ¶ 6.) This completely unexpected change in the proposed ADF regulation is a substantial nonconformity with the requirements of the Administrative Procedure Act and is prejudicial, given its potential impact on the environmental impacts of the ADF regulation.

ADF F5-6

The 15-Day Notice also reveals increases in previously disclosed impacts. For example, the 15-Day Notice states that biodiesel adaptation will be lower than previously estimated, resulting in increased NOx impacts from biodiesel, and smaller statewide reductions of NOx compared to the original regulation. (See 15-Day Notice at 12.)

ADF F5-7

Further, a review of the Multimedia Evaluation discloses numerous material inconsistencies between that document and the EA, all of which call into question both the adequacy of CARB's analysis, and the integrity of CARB staff's conclusion that the ADR regulation (either as originally proposed or as modified) will not result in significant increases in NOx emissions. For example, the Multimedia Analysis does not include material information (that *was* included with the ISOR) that tended to suggest a link between the ADF and increased NOx emissions, and the ISOR and the Multimedia Evaluation use different baselines for the analysis of biodiesel [the ISOR assumes 65 million gallons of existing usage, while the Multimedia Evaluation assumes no biodiesel usage].

For example, the Multimedia Evaluation omits a finding that "NOx emission increases due to soy biodiesel are statistically significant"; the increases, expressed in tons per day, in NOx emissions due to the ADF shown in Tables 7.1 and B-1 of the ISOR; the Supplemental Statistical Analysis presented in Appendix G of the ISOR; peer review papers contradicting CARB's claims regarding the impact of biodiesel on NOx emissions from NTDEs; and documents presented during the public review process that contradict CARB's findings. (Decl. Lyons ¶¶ 15-16.)

ADF F5-8

In addition, because of these discrepancies, the findings in the EA – including the finding that the proposed ADF regulation will not result in significant impacts to the environment – are not supported by substantial, credible evidence. (See, e.g., *Preserve Wild Santee v. City of Santee* (2012) 210 Cal.App.4th 260, 283-84 [finding that

ADF F5-9

unexplained discrepancy precluded the existence of substantial evidence of adequate water supply] [citing *Vineyard Area Citizens for Responsible Growth, Inc. v. City of Rancho Cordova* (2007) 40 Cal.4th 412, 439].)

Plainly, new information has been disclosed that effects the conclusions in the EA. Among other things, the 15-Day Notice reveals a substantial increase in the severity of environmental impact (*i.e.*, NOx emissions). No mitigation has been adopted to reduce this impact to a less-than-significant level. Further, the fact that the 15-Day Notice contains no information to support CARB's conclusions demonstrates CARB's analysis is so fundamentally and basically inadequate and conclusory in nature that public comment on these issues is essentially meaningless. (See *Laurel Heights Improvement Ass'n v. Regents of Univ. of Calif.* (1993) 6 Cal.4th 1112, 1130; *cf.* CEQA Guidelines, § 15088.5(a).)

ADF F5-9 cont.

Despite this, the EA was not modified or recirculated for public review. CARB cannot comply with CEQA unless it updates the analysis in the EA, and recirculates the revised EA for a full 45-day public review, to which the staff must respond and which the Board must consider prior to any regulatory approval.

D. CARB Should Revise its Pilot Program to Ensure the Potential Environmental Effects of New Fuels Will Be Properly Evaluated

The ADF regulation contemplates that proposed alternative diesel fuels, other than biodiesel, will be introduced through a pilot program, and evaluation by CARB staff, prior to the entry of the fuel into the market.

In the 15-Day Notice, CARB has modified the pilot program to, among other things, add "significant adverse environmental impacts as a reason for disapproving a proposed pilot program." (15-Day Notice at 3.) This modification raises several concerns:

1. The Proposed Modifications Impermissibly Allow CARB to Defer Analysis and Mitigation of Environmental Effects

Except under unusual circumstances not present here, CEQA prohibits an agency from deferring analysis of environmental impacts and mitigation. "CEQA contemplates consideration of environmental consequences at the 'earliest possible stage,'" (*Rio Vista Farm Bureau v. County of Solano* (1992) 5 Cal.App.4th 351, 370 [quoting *Leonoff v. Monterey County Bd. of Supers.* (1990) 222 Cal.App.3d 1337, 1346]), and the "requirements of CEQA cannot be avoided by piecemeal review which results from chopping a large project into many little ones—each with a minimal potential impact on the environment—which cumulatively may have disastrous consequences." (*EPIC v. Dept. of Forestry & Fire Prot.* (2008) 44 Cal.4th 459, 503.)

ADF F5-10

An agency likewise may not defer mitigation, which "occurs when an EIR" or functional equivalent "puts off analysis or orders a report without either setting standards or demonstrating how the impact can be mitigated in the manner described in the"

environmental document. (*City of Long Beach, supra*, 176 Cal.App.4th at 915.) Thus, a mitigation measure that merely calls for a mitigation plan to be devised based on future studies or analysis is legally inadequate if it does not include performance standards that would mitigate the significant impact. (*Comms. for a Better Env., supra*, 184 Cal.App.4th at 95; *Endangered Habitats, supra*, 131 Cal.App.4th at 794 [rejecting mitigation requiring submission of acoustical analysis and approval of mitigation measures recommended by analysis because no mitigation criteria or potential mitigation measures were identified].)

ADF F5-10 cont.

In this case, CARB is essentially seeking to defer analysis of the environmental impacts of a candidate ADF to a later date. If the candidate ADF has such impacts, ARB staff is able to "consider the effects of offsetting factors," and adopt "conditions of use." In other words, instead of analyzing the full impacts of fuels that are alternatives to diesel fuels on the front end, CARB is allowing the Executive Officer, without performance standards, to both analyze potential impacts of candidate ADFs and consider mitigation (*i.e.*, "offsetting factors" and "conditions of use"). CARB cannot defer analysis of alternative diesels in this manner, and must instead provide the Executive Officer with reasonable performance standards to govern the review of new candidate ADFs.

2. The Proposed Modification Constitutes Impermissible Piecemealing of Environmental Review

The "requirements of CEQA cannot be avoided by piecemeal review which results from chopping a large project into many little ones—each with a minimal potential impact on the environment—which cumulatively may have disastrous consequences." (*Envt'l Prot. Info. Ctr. v. Calif. Dept. of Forestry & Fire Prot.* (2008) 44 Cal.4th 459, 503.) CEQA, therefore, "forbids 'piecemeal' review of the significant environmental impacts of a project." (*Berkeley Keep Jets Over the Bay Comm. v. Bd. of Port Comm'rs* (2011) 91 Cal.App.4th 1344, 1358.) Rather, when a lead agency undertakes the environmental review process, the lead agency must review and consider the "*whole* of the action," (CEQA Guidelines, § 15378 [emphasis added]), and consider "the effects, both individual and *collective*, of all activities involved in [the] project." (Pub. Resources Code, § 21002.1, subd. (d).) It is only through a complete and accurate "view of the project may affected outsiders and public decision-makers balance the proposal's benefit against its environmental cost, consider mitigation measures, assess the advantage of terminating the proposal . . . and weigh other alternatives in the balance." (*Berkeley Keep Jets, supra*, 91 Cal.App.4th at 1358.)

ADF F5-11

As explained above, the Executive Officer will be reviewing the environmental impacts of candidate ADFs as applications are filed, without the benefit of performance standards or other criteria for the review. In other words, the impacts of the individual candidate ADFs will be reviewed on a case-by-case basis. While the individual impacts of such candidate ADFs may not be significant standing alone, the effects of such candidate ADFs in the *aggregate* may be significant. CARB should be required to analyze candidate ADFs as a whole, and provide the Executive Officer with performance standards to ensure a significant increase in NOx emissions will not occur.

3. The Proposed Modifications Constitute an Impermissible *Post Hoc* Environmental Review that CARB May Not Delegate to the Executive Officer

CEQA prohibits the delegation of important functions, including review and consideration of an EIR or its equivalent, to a person or entity ***other than*** the body with final decision making authority over the project. (CEQA Guidelines, § 15025.) Thus, the decision-making body with final authority over project approval must also be the entity that certifies the EIR or functional equivalent. (*Sundstrom v. County of Mendocino* (1988) 202 Cal.App.3d 296, 307 [holding that board of supervisors with decision-making approval over the project "cannot delegate the responsibility" to certify the EIR "to the staff of the planning commission"]; *Kleist, supra,* 56 Cal.App.3d at 772, 779 [invalidating EIR where city council that approved the project delegated certification of the related EIR to planning board created by city ordinance]; *El Morro Community Assoc. v. Dept. Parks & Recr.* (2004) 122 Cal.App.4th 1341, 1350-51 [explaining that *Sundstrom* and *Kleist* "hold the decision maker may not delegate CEQA approval to a non-decision maker," but distinguishing those cases because "Deputy Director" who certified the EIR was also "designee to approve the project"].) The reason is clear: the environmental review document "cannot serve its informational function unless it is reviewed and considered by the governmental body which takes action having an effect upon the environment." (*Kleist, supra,* 56 Cal.App.3d at 779; see also *POET, LLC v. Calif. Air Resources Board* (2013) 217 Cal.App.4th 1214.)

ADF F5-12

Here, the Executive Officer intends to review future candidate ADFs, and determine whether those candidate ADFs will have negative environmental effects. While CARB may not be required to speculate regarding the specific characteristics of any particular fuel, as the ISOR (and the comments submitted by Growth Energy and others) itself reveals, CARB *can* evaluate the potential effects of such fuels at a general level, and adopt performance standards (*i.e.*, no increase in NOx emissions) to help govern the subsequent environmental review. By waiting until *after* the ADF regulation is approved to review even generalized effects without establishing performance standards, however, CARB is impermissibly delegating the environmental review processes to a non-decisionmaker, and allowing the environmental review to occur *after* project approval. This procedure violates CEQA.

E. CARB's Analysis of the Air Quality Impacts of the Proposed ADF Regulation Impermissibly Contemplates the Use of Different Baselines for Biodiesels and Other Alternative Diesel Fuels

Neither CARB's 15-Notice nor the "Updated ADF NOx Analysis" presented in Table 1 of the notice address one of the primary flaws in CARB's environmental analysis. Specifically, CARB has used "a baseline for determining the significance of increased NOx emissions from biodiesel use where 65 million gallons of biodiesel are already in-use to conclude" the ADF regulation will not have a significant impact on the environment. (Decl. Lyons ¶ 11; see also ISOR at 47 ["The net impacts of the proposal reduce NOx impacts from biodiesel, even assuming increased biodiesel

ADF F5-13

volumes over the subsequent years. Estimated impacts under the proposal are less than the baseline (current year) and will continue to decrease as NTDE use increases in California."].)

For fuels other than biodiesel, however, both the ISOR and the 15-Day Notice use a baseline that assumes the ADF regulation does not exist. (Decl. Lyons ¶ 11.)

CARB cannot evaluate the impacts of biodiesel and other alternative diesels on different playing fields by providing different environmental baselines. (See, e.g., *Woodward Park Homeowners Ass'n, Inc. v. City of Fresno* (2007) 150 Cal.App.4th 683, 707-10.) This is particularly true here, where a later baseline would obscure the impacts of biodiesel (a significant source of increased NOx emissions).

In short, all alternative diesels should be evaluated under the same rules, and using the same environmental baseline. Without this even playing field, the proposed modifications violate CEQA.

ADF F5-13 cont.

F. CARB Violated Section 57004 of the Health & Safety Code By Failing to Conduct a Peer Review of the ADF Regulation

Section 57004 of the Health & Safety Code provides that CARB shall not "take any action to adopt the final version of a rule unless" it undertakes a peer review to evaluate the scientific basis for the rule. (Health & Safety Code, § 57004(d).) That section requires: (1) that CARB "submit[] the scientific portions of the proposed rule, along with a statement of the scientific findings, conclusions, and assumptions on which the scientific portions of the proposed rule are based and the supporting scientific data, studies, and other appropriate materials, to the external scientific peer review entity for its evaluation," and (2) the peer reviewer "prepares a written report that contains an evaluation of the scientific basis of the proposed rule." (*Id.*)

CARB violated Section 57004 because it did not engage any expert to undertake a peer review of the ADF regulation. While CARB apparently takes the position that it retained peer reviewers for the Multimedia Evaluations on the two fuels, that is not sufficient, as those Multimedia Evaluations relate to the fuels, and not the ADF regulation. They are likewise not the type of peer review contemplated for the enactment of a regulation under Section 57004.

ADF F5-14

Further, many aspects of the ADF regulation would benefit greatly from the inclusion of comments from an independent peer reviewer. For example, one highly controversial issue associated with the ADF regulation is the fact that NOx increases still occur below B5, as explained in the analysis submitted by Robert Crawford on behalf of Growth Energy.

Another significant issue is the data indicating the ADF regulation would cause large increases in NOx emissions due to NTDEs associated with increased biodiesel usage. Despite these contested issue, there is no peer review on either point.

Because CARB did not conduct ***any*** peer review of the "scientific basis" for the ADF regulation – let alone a peer review of the more controversial scientific issues raised by the public – CARB has failed to comply with Section 57004 of the Health & Safety Code.

These failures can and should be readily corrected in short order. CARB need only postpone the currently rulemaking process by 60-90 days, which should not jeopardize its intended effective date for the proposed ADF regulation. If CARB does not engage in this process, it will constitute a prejudicial abuse of discretion.

ADF F5-14 cont.

STATE OF CALIFORNIA

BEFORE THE AIR RESOURCES BOARD

Declaration of James M. Lyons

I, James Michael Lyons, declare as follows:

1. I make this Declaration based upon my own personal knowledge and my familiarity with the matters recited herein. It is based on my experience of nearly 30 years as a regulator, consultant, and professional in the field of emissions and air pollution control. A copy of my résumé can be found in Attachment A.

2. I am a Senior Partner of Sierra Research, Inc., an environmental consulting firm located at 1801 J Street, Sacramento, California owned by Trinity Consultants, Inc. Sierra specializes in research and regulatory matters pertaining to air pollution control, and does work for both governmental and private industry clients. I have been employed at Sierra Research since 1991. I received a B.S. degree in Chemistry from the University of California, Irvine, and a M.S. Degree in Chemical Engineering from the University of California, Los Angeles. Before joining Sierra in 1991, I was employed by the State of California at the Mobile Source Division of the California Air Resources Board (CARB).

3. During my career, I have worked on many projects related to the following areas: 1) the assessment of emissions from on- and non-road mobile sources, 2) assessment of the impacts of changes in fuel composition and alternative fuels on engine emissions including emissions of green-house gases, 3) analyses of the unintended consequences of regulatory actions, and 4) the feasibility of compliance with air quality regulations.

4. I have testified as an expert under state and federal court rules in cases involving CARB regulations for gasoline, Stage II vapor recovery systems and their design, factors affecting emissions from diesel vehicles, evaporative emission control system design and function, as well as combustion chamber system design. While at Sierra I have acted as a consultant on automobile air pollution control matters for CARB and for the United States Environmental Protection Agency. I am a member of the American Chemical Society and the Society of Automotive Engineers and have co-authored nine peer-reviewed monographs concerned with automotive emissions, including greenhouse gases and their control. In addition, over the course of my career, I have conducted peer-reviews of numerous papers related to a wide variety of issues associated with pollutant emissions and air quality.

5. This Declaration summarizes the results of my review of the CARB Notice of Public Availability of Modified Text and Availability of Additional Documents for the Proposed Regulation on the Commercialization of Alternative Diesel Fuels (the ADF Regulation) dated May 22, 2015, and the California Environmental Protection Agency's Staff Report, Multi-Media Evaluation of Biodiesel, Prepared by the Multimedia Working

Group and dated May 2015, which has been added by CARB to the ADF rulemaking file. I have performed this critical review as an independent expert for Growth Energy. If called upon to do so, I would testify in accord with the facts and opinions presented here.

6. Based on my review of the changes proposed to the ADF regulation by CARB, the new exemption from mitigation requirements for B6 to B20 fuels provided through Section 2293(a)(5)(C) creates the potential for significant increases in NOx emissions from vehicles operating in areas outside the South Coast or San Joaquin Valley Air Basins. I have participated in every aspect of the development of the ADF regulation in which a member of the public was allowed by CARB to participate. The new exemption could not reasonably have been anticipated, based on the notice of proposed rulemaking and the supporting materials made available in December 2014.

7. CARB staff agrees on page 11 of the notice that the new exemption could result in increased NOx emissions. However, CARB staff claims on pages 11 to 13 of the notice that the agency has conducted "additional analysis" of NOx emissions related to a number of new issues, including the new exemption that will be added to the ADF Regulation record, and concluded that the overall impact of the ADF regulation on NOx emissions will be smaller than it originally estimated. Unfortunately, CARB has failed to provide the detailed information required for public review and comment. As a result, it was not possible for me to review the data and assumptions used by CARB staff, nor to reach a conclusion about the accuracy of the analysis that was purported to have been performed or the conclusions drawn from the analysis by CARB.

8. The notice claims, based on undisclosed "additional analysis," that increased emissions due to the new exemption will be mitigated on a statewide basis averaged over an entire year. Even assuming the "additional analysis" is correct, higher NOx emissions could occur due to the new exemption in areas outside the South Coast or San Joaquin Valley Air Basins which are not in attainment with federal and state ambient air quality standards for ozone. Although the South Coast and San Joaquin Valley Air Basins experience the highest ozone levels in the state, there are many other areas in non-attainment of the federal[1] and state[2] standards where increased NOx emissions could create adverse impacts on air quality.

ADF F5-15

9. CARB should be required to provide the necessary data to perform a careful assessment. Increased NOx emissions resulting from the new exemption could potentially be significant. This can be seen through a comparison of the criteria used to assess air quality impacts in areas of California outside the South Coast and San Joaquin Air Basins and the increases in NOx emissions estimated to result from biodiesel use. Using the Sacramento Metropolitan Air Quality Management District as an example,[3] the significance threshold for NOx emissions projects subject to CEQA is 65 pounds per day

ADF F5-16

[1] See http://www.arb.ca.gov/desig/adm/2013/fed_o3.pdf
[2] See http://www.arb.ca.gov/desig/adm/2013/state_o3.pdf
[3] See http://airquality.org/ceqa/ceqaguideupdate.shtml

or 0.0325 tons per day. Using the data in the row labeled "Emission Inventory (Diesel TPD)" in Table 1 of the CARB Notice, 0.0325 tons per day can be compared to both the 0.95 ton per day estimate for 2016 statewide increases in NOx due to the ADF regulation in Table 1 of the notice, and also the difference between that value and the 1.27 ton per day value that was CARB's original estimate. Clearly, if the new exemption results in the use of even a small amount of biodiesel in the Sacramento area without mitigation, the increase in NOx emissions could be significant. Further, similar situations where significant increases in NOx emissions occur in other ozone non-attainment areas outside of the South Coast and San Joaquin Air Basins can be expected.

ADF F5-16 cont.

10. The only way to ensure that increased NOx emissions due to the new exemption would not potentially lead to adverse air quality impacts in areas where it is allowed, and thus mitigate impacts to NOx caused by the exemption, would be to require that appropriate amounts of renewable diesel biodiesel are used in the same location and at the same time as the biodiesel provided for under the new exemption. The only way to ensure this would happen would be to require blending of renewable diesel into the biodiesel blends allowed under the new exemption. There is no such requirement in the ADF regulation.

ADF F5-17

11. Another major problem with CARB's "Updated ADF NOx Analysis" presented in Table 1 of the Notice is that CARB has failed to address a key flaw in its analysis of the adverse environmental impacts of biodiesel. This flaw relates to using a baseline for determining the significance of increased NOx emissions from biodiesel use where 65 million gallons of biodiesel are already in-use to conclude, as stated on page 47 of the Initial Statement of Reasons for the ADF regulation, that:

> *The net impacts of the proposal reduce NOx impacts from biodiesel, even assuming increased biodiesel volumes over the subsequent years. Estimated impacts under the proposal are less than the baseline (current year) and will continue to decrease as NTDE use increases in California.*

ADF F5-18

The correct baseline that is used everywhere else in the ISOR, as well as in the Multi-Media Evaluation and by the Peer Reviewers of that evaluation, is CARB diesel fuel containing **no** biodiesel. Given that the purpose of the ADF regulation is to establish specifications for fuels like biodiesel while identifying and ensuring mitigation of adverse environmental impacts, the no biodiesel baseline is clearly the correct baseline. Based on CARB's own "Updated ADF NOx Analysis," use of this baseline shows unmitigated NOx increases of about one ton per day statewide in California in 2015, 2016, and 2017, and at lower levels through 2020, despite its flaws. Further, as shown in my previous declaration, submitted to CARB prior to the ADF and LCFS public hearings in February 2015, the likely increases in NOx emissions are much larger and can be expected to continue indefinitely into the future.

When viewed in the context of the proper baseline, the data presented in Table 1 of the notice show that the proposed ADF regulation, even after CARB's update of its analysis, fails to mitigate increased NOx emissions due to biodiesel use. That CARB has erred in

establishing the baseline for analysis of biodiesel NOx impacts is support by the ADF regulation itself, as sections 2293.5(a)(3)(C), 2293.5(b)(3)(C), 2293.5(b)(5)(B), 2293.5(b)(5)(D), and 2293.5(b)(6)(B), make it clear that increased emissions from an ADF will not be included in baseline. Rather, the baseline required to be used has to reflect conditions in place before the use of the ADF.

ADF F5-18 cont.

12. Notwithstanding the above, CARB's "additional analysis" is also fatally flawed for all of the other reasons set forth in my previous declaration and its attachments dated February 17th 2015, which was filed as part of Growth Energy's comments during the original 45 day comment period on the ADF regulation.

ADF F5-19

13. Turning to the Staff Report on the Multimedia Evaluation of Biodiesel that has only recently become available for public comment and is now being included in the ADF regulation record, I have reviewed the air quality assessment that is reported to have been prepared by CARB staff, and have found it to be both inconsistent with the analysis presented in the ADF ISOR as well as fatally flawed in that it fails to consider all of the available information regarding the impact of biodiesel on NOx emissions from what CARB refers to as New Technology Diesel Engines (NTDEs). As a direct result, the Supplemental External Scientific Peer Review of the air quality impacts of biodiesel is also flawed.

14. The primary conclusion of the Multimedia Evaluation of Biodiesel with respect to air quality is:

> *Based on a relative comparison between biodiesel and CARB diesel (containing no biodiesel), ARB staff concludes that with in-use requirements biodiesel, as specified in the multimedia evaluation and proposed regulation, does not pose a significant adverse impact on public health or the environment from potential air quality impacts.*

ADF F5-20

This statement clearly highlights the fundamental inconsistency between the baseline used in the ISOR analysis of air quality impacts, where the baseline included biodiesel use, and the baseline identified in the Multimedia Evaluation Staff Report which included no biodiesel. As noted above, the appropriate baseline is the one identified in the Multimedia Evaluation Staff Report.

15. Another major inconsistency between the Multimedia Evaluation and the ISOR is the fact that CARB failed to include much of the information found in Chapters 6 and 7, and in Appendices B and G of the ISOR, all of which addresses the impact of biodiesel on emissions and air quality in the Multimedia Evaluation. Key information omitted includes:

ADF F5-21

- The finding that NOx emission increases due to soy biodiesel are statistically significant based on all data considered on page 40 of the ISOR;

- The ton per day increases in NOx emissions due to the ADF shown in Tables 7.1 and B-1 of the ISOR;

- The Supplemental Statistical Analysis presented in Appendix G of the ISOR; and

- The following peer reviewed technical papers listed as references 21 through 24 for Chapter 6 of the ISOR, which contradict CARB's claims regarding the impact of biodiesel on NOx emissions from NTDEs:

    - Gysel, Nicholas et al., *Emissions and Redox Activity of Biodiesel Blends Obtained from Different Feedstocks from a Heavy-Duty Vehicle Equipped with DPF/SCR Aftertreatment and a Heavy-Duty Vehicle without Control Aftertreatment*, SAE 2014-01-1400, Published 04/01/2014.

    - McWilliam, Lyn and Zimmermann, Anton, *Emission and Performance Implications of Biodiesel Use in an SCR-equipped Caterpillar C6.6*, SAE 2010-012157 Published, 10/25/2010.

    - Mizushima, Norifumi and Nurata, Yutaka, *Effect of Biodiesel on NOx Reduction Performance of Urea-SCR system*, SAE 2010-01-2278, Published 10/25/2010.

    - Walkowicz, Kevin et al., *On-Road and In-Laboratory Testing to Demonstrate Effects of ULSD, B20, and B99 on a Retrofit Urea-SCR Aftertreatment System*, SAE 2009-01-2733.

ADF F5-21 cont.

CARB's failure to include and fully to address the foregoing information and analysis made it impossible for any external reviewers, who were relying upon CARB for full disclosure of all relevant data and information, to perform a credible scientific review of the emissions and air quality evaluation and the conclusions reached by CARB.

16. Similarly, CARB failed to include data and information directly relevant to the issues of biodiesel impacts on emissions and air quality provided during the public comment period on the ADF regulation in the materials considered in the Multimedia Evaluation Staff Report, and therefore by the external reviewers. Data and information provided during the public comment period that contradict CARB's findings regarding biodiesel NOx impacts on NTDEs that was not made part of the Multimedia Evaluation includes:

ADF F5-22

- "NOx Emission Impacts of Biodiesel Blends," Robert Crawford, Rincon Ranch Consulting, February 17, 2015; and

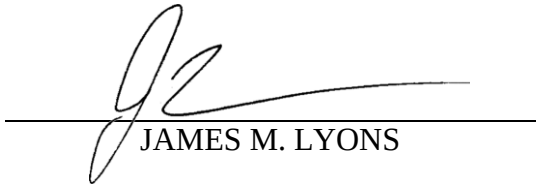
- Declaration of James M. Lyons, February 17, 2015, with attachments.

Again, CARB's failure to include this information also made it impossible for the Peer Reviewers, who were relying upon CARB for full disclosure of all relevant data and information, to perform a credible scientific review of the emissions and air quality evaluation and the conclusions reached by CARB.

ADF F5-22
cont.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Executed this 8th day of June, 2015 at Sacramento, California.



JAMES M. LYONS

ATTACHMENT A

RÉSUMÉ

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Résumé

James Michael Lyons

Education

1985, M.S., Chemical Engineering, University of California, Los Angeles

1983, B.S., Cum Laude, Chemistry, University of California, Irvine

Professional Experience

4/91 to present — Senior Engineer/Partner/Senior Partner
Sierra Research

Primary responsibilities include oversight and execution of complex analyses of the emission benefits, costs, and cost-effectiveness of mobile source air pollution control measures. Mr. Lyons has developed particular expertise with respect to the assessment of control measures involving fuel reformulation, fuel additives, and alternative fuels, as well as accelerated vehicle/engine retirement programs, the deployment of advanced emission control systems for on- and non-road gasoline- and Diesel-powered engines, on-vehicle evaporative and refueling emission control systems, and Stage I and Stage II service station vapor recovery systems. Additional duties include assessments of the activities of federal, state, and local regulatory agencies with respect to motor vehicle emissions and reports to clients regarding those activities. Mr. Lyons has extensive litigation experience related to air quality regulations, product liability, and intellectual property issues.

7/89 to 4/91 — Senior Air Pollution Specialist
California Air Resources Board

Supervised a staff of four professionals responsible for identifying and controlling emissions of toxic air contaminants from mobile sources and determining the effects of compositional changes to gasoline and diesel fuel on emissions of regulated and unregulated pollutants. Other responsibilities included development of new test procedures and emission standards for evaporative and running loss emissions of hydrocarbons from vehicles; overseeing the development of the state plan to control toxic emissions from motor vehicles; and reducing emissions of CFCs from motor vehicles.

4/89 to 7/89 Air Pollution Research Specialist
California Air Resources Board

Responsibilities included identification of motor vehicle research needs; writing requests for proposals; preparation of technical papers and reports; as well as monitoring and overseeing research programs.

9/85 to 4/89 Associate Engineer/Engineer
California Air Resources Board

Duties included analysis of vehicle emissions data for trends and determining the effectiveness of various types of emissions control systems for both regulated and toxic emissions; determining the impact of gasoline and diesel powered vehicles on ambient levels of toxic air contaminants; participation in the development of regulations for "gray market" vehicles; and preparation of technical papers and reports.

Professional Affiliations

American Chemical Society
Society of Automotive Engineers

Selected Publications (Author or Co-Author)

"Development of Vehicle Attribute Forecasts for 2013 IEPR," Sierra Research Report No. SR2014-01-01, prepared for the California Energy Commission, January 2014.

"Assessment of the Emission Benefits of U.S. EPA's Proposed Tier 3 Motor Vehicle Emission and Fuel Standards," Sierra Research Report No. SR2013-06-01, prepared for the American Petroleum Institute, June 2013.

"Development of Inventory and Speciation Inputs for Ethanol Blends," Sierra Research Report No. SR2012-05-01, prepared for the Coordinating Research Council, Inc. (CRC), May 2012.

"Review of CARB Staff Analysis of 'Illustrative' Low Carbon Fuel Standard (LCFS) Compliance Scenarios," Sierra Research Report No. SR2012-02-01, prepared for the Western States Petroleum Association, February 20, 2012.

"Review of CARB On-Road Heavy-Duty Diesel Emissions Inventory," Sierra Research Report No. SR2010-11-01, prepared for The Ad Hoc Working Group, November 2010.

"Identification and Review of State/Federal Legislative and Regulatory Changes Required for the Introduction of New Transportation Fuels," Sierra Research Report No. SR2010-08-01, prepared for the American Petroleum Institute, August 2010.

"Technical Review of EPA Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis for Non-GHG Pollutants," Sierra Research Report No. SR2010-05-01, prepared for the American Petroleum Institute, May 2010.

"Effects of Gas Composition on Emissions from Heavy-Duty Natural Gas Engines," Sierra Research Report No. SR2010-02-01, prepared for the Southern California Gas Company, February 2010.

"Effects of Gas Composition on Emissions from a Light-Duty Natural Gas Vehicle," Sierra Research Report No. SR2009-11-01, prepared for the Southern California Gas Company, November 2009.

"Technical Review of 2009 EPA Draft Regulatory Impact Analysis for Non-GHG Pollutants Due to Changes to the Renewable Fuel Standard," Sierra Research Report No. SR2009-09-01, prepared for the American Petroleum Institute, September 2009.

"Effects of Vapor Pressure, Oxygen Content, and Temperature on CO Exhaust Emissions," Sierra Research Report No. 2009-05-03, prepared for the Coordinating Research Council, May 2009.

"Technical Review of 2007 EPA Regulatory Impact Analysis Methodology for the Renewable Fuels Standard," Sierra Research Report No. 2008-09-02, prepared for the American Petroleum Institute, September 2008.

"Impacts of MMT Use in Unleaded Gasoline on Engines, Emission Control Systems, and Emissions," Sierra Research Report No. 2008-08-01, prepared for McMillan Binch Mendelsohn LLP, Canadian Vehicle Manufacturers' Association, and Association of International Automobile Manufacturers of Canada, August 2008.

"Attachment to Comments Regarding the NHTSA Proposal for Average Fuel Economy Standards Passenger Cars and Light Trucks Model Years 2011-2015, Docket No. NHTSA-2008-0089," Sierra Research Report No. SR2008-06-01, prepared for the Alliance of Automobile Manufacturers, June 2008.

"Evaluation of California Greenhouse Gas Standards and Federal Energy Independence and Security Act – Part 1: Impacts on New Vehicle Fuel Economy," SAE Paper No. 2008-01-1852, Society of Automotive Engineers, 2008.

"Basic Analysis of the Cost and Long-Term Impact of the Energy Independence and Security Act Fuel Economy Standards," Sierra Research Report No. SR 2008-04-01, April 2008.

"The Benefits of Reducing Fuel Consumption and Greenhouse Gas Emissions from Light-Duty Vehicles," SAE Paper No. 2008-01-0684, Society of Automotive Engineers, 2008.

"Assessment of the Need for Long-Term Reduction in Consumer Product Emissions in South Coast Air Basin," Sierra Research Report No. 2007-09-03, prepared for the Consumer Specialty Products Association, September 2007.

"Summary of Federal and California Subsidies for Alternative Fuels," Sierra Research Report No. SR2007-04-02, prepared for the Western States Petroleum Association, April 2007.

"Analysis of IRTA Report on Water-Based Automotive Products," Sierra Research Report No. SR2006-08-02, prepared for the Consumer Specialty Projects Association and Automotive Specialty Products Alliance, August 2006.

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319. Comment: **ADF F5-1 through ADF F5-13, and ADF 5-15 through ADF 5-22 EA**

Agency Response: The responses to these comments are in "Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations."

320. Comment: **ADF F5-14** The comments suggests that ARB violated Health and Safety Code 57004 by not conducting a peer review of the regulation.

Agency Response: ARB staff disagrees, as the ADF regulation did adhere to statutory requirements. The statutory requirement HSC 57004 required a peer review to be conducted on the scientific basis or portions of a regulation. The multimedia evaluations for biodiesel and renewable diesel reflect the scientific basis of the ADF regulations, which did undergo peer review pursuant to HSC 57004.