

State of California  
AIR RESOURCES BOARD

**PUBLIC HEARING TO CONSIDER PROPOSED AMENDMENTS TO THE LOW  
CARBON FUEL STANDARD REGULATION AND TO THE REGULATION ON  
COMMERCIALIZATION OF ALTERNATIVE DIESEL FUELS**

**STAFF REPORT: INITIAL STATEMENT OF REASONS**

**DATE OF RELEASE: March 6, 2018**  
**SCHEDULED FOR CONSIDERATION: April 27, 2018**

This report has been reviewed by the staff of the California Air Resources Board and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Air Resources Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

This Page Intentionally Left Blank

**Staff Report: Initial Statement of Reasons for the Proposed Amendments to the Low Carbon Fuel Standard Regulation**

**PUBLIC HEARING TO CONSIDER PROPOSED AMENDMENTS TO THE LOW CARBON FUEL STANDARD REGULATION AND TO THE REGULATION ON COMMERCIALIZATION OF ALTERNATIVE DIESEL FUELS**

Date of Release: **March 6, 2018**  
Scheduled for Consideration: **April 27, 2018**

**TABLE OF CONTENTS**

**Executive Summary ..... EX-1**

**I. INTRODUCTION AND BACKGROUND ..... I-1**

A. Overview of the LCFS ..... I-1

B. History and Current Status of the LCFS ..... I-4

C. Overview of the Proposed Amendments ..... I-7

**II. THE PROBLEM THAT THE PROPOSAL IS INTENDED TO ADDRESS ..... II-1**

A. Strengthen the Average Carbon Intensity Requirements Through 2030 ..... II-2

B. New Fuels Subject to the Regulation ..... II-4

C. Addition of Third-party Verification ..... II-9

D. Other Proposed Amendments ..... II-10

**III. THE SPECIFIC PURPOSE OF EACH ADOPTION, AMENDMENT, OR REPEAL & THE RATIONALE FOR CARB’S DETERMINATION THAT EACH IS REASONABLY NECESSARY ..... III-1**

**IV. BENEFITS OF THE PROPOSED AMENDMENTS ..... IV-1**

A. Reduced GHG Emissions ..... IV-1

B. Reduced Criteria Pollutant and Toxic Air Contaminant Emissions ..... IV-3

C. Greater Opportunities for California Businesses to Invest in Low Carbon Transportation Technologies ..... IV-4

D. Reduced Dependence on Fossil Fuels ..... IV-5

**V. AIR QUALITY ..... V-1**

A. Overview of the Air Quality Analysis and Major Findings ..... V-1

B. Baseline Condition ..... V-4

C. Illustrative Compliance Scenario ..... V-10

D. Changes of Emissions in Response to the Proposed Amendments ..... V-11

E. Health Impacts Analysis ..... V-22

F. Localized Health Risk Assessment for a Potential California Biofuel Facility ..... V-25

G.	Analysis Performed Relative to Low Carbon Fuel Standard Targets Remaining Constant at 10 Percent Reduction from 2021 to 2030 .....	V-26
<b>VI.</b>	<b>ENVIRONMENTAL ANALYSIS .....</b>	<b>VI-1</b>
<b>VII.</b>	<b>ENVIRONMENTAL JUSTICE .....</b>	<b>VII-1</b>
A.	LCFS, Climate Change Scoping Plan, and Related Environmental Justice Efforts to Date .....	VII-1
B.	EJ Overview on the Current LCFS Program .....	VII-4
C.	The Proposed LCFS Amendments .....	VII-7
D.	Carbon Capture and Sequestration (CCS).....	VII-9
E.	Conclusion .....	VII-9
<b>VIII.</b>	<b>ECONOMIC IMPACTS ANALYSIS.....</b>	<b>VIII-1</b>
A.	Overview .....	VIII-1
B.	Benefits .....	VIII-2
C.	Costs.....	VIII-3
D.	Fiscal Impacts .....	VIII-4
E.	Macroeconomic Impacts .....	VIII-5
F.	Alternatives .....	VIII-6
G.	Sensitivity Analysis.....	VIII-7
<b>IX.</b>	<b>EVALUATION OF REGULATORY ALTERNATIVES.....</b>	<b>IX-1</b>
<b>X.</b>	<b>JUSTIFICATION FOR ADOPTION OF REGULATIONS DIFFERENT FROM FEDERAL REGULATIONS CONTAINED IN THE CODE OF FEDERAL REGULATIONS .....</b>	<b>X-1</b>
<b>XI.</b>	<b>PUBLIC PROCESS FOR DEVELOPMENT OF THE PROPOSED ACTION (PRE-REGULATORY INFORMATION) .....</b>	<b>XI-1</b>
<b>XII.</b>	<b>REFERENCES.....</b>	<b>XII-1</b>
<b>XIII.</b>	<b>APPENDICES .....</b>	<b>XIII-1</b>

## LIST OF FIGURES

Figure EX-1:	Current and Proposed Annual Carbon Intensity Benchmarks as Compared to CI Reductions Achieved in 2017 by the Most Common Alternative Fuels .....	EX-3
Figure EX-2:	Estimated Credit Prices for the Baseline and Proposed Amendments Scenarios.....	EX-10
Figure I-1:	Illustration of LCFS Mechanics: How Credits and Deficits are Calculated ..	I-2

Figure I-2:	Total Credits and Deficits for All Fuels Reported and Cumulative Credit Bank.....	I-5
Figure I-3:	Annual Growth in Alternative Fuel Volumes and Credit Generation by Fuel Type.....	I-6
Figure II-1:	Current and Proposed Annual Carbon Intensity Benchmarks as Compared to CI Reductions Achieved in 2017 by the Most Common Alternative Fuels .....	II-4
Figure IV-1:	Estimated LCFS GHG Emission Reductions for 2019 to 2030 Attributable to the LCFS (MMTCO <sub>2</sub> e).....	IV-3
Figure V-1:	Estimated Statewide NO <sub>x</sub> Emissions Impact of the Proposed LCFS Amendments Relative to 2016 Baseline (tons/year) .....	V-2
Figure V-2:	Estimated Statewide PM <sub>2.5</sub> Emissions Impact of the Proposed LCFS Amendments Relative to 2016 Baseline (tons/year) .....	V-3
Figure V-3:	Illustrative Fuel Volumes that Can Meet the Proposed Amendments (Proposed Amendments Scenario).....	V-10
Figure V-4:	Estimated Change in NO <sub>x</sub> Emissions Due to LCFS-Attributed Biodiesel and Renewable Diesel Use.....	V-13
Figure V-5:	Estimated Change in PM Emissions Due to LCFS-Attributed Biodiesel and Renewable Diesel Use.....	V-14
Figure V-6:	Estimated Change in NO <sub>x</sub> Emissions for Biofuel Feedstock and Finished Fuel Transportation and Distribution Relative to 2016 Baseline .....	V-15
Figure V-7:	Estimated Change in PM <sub>2.5</sub> Emissions for Biofuel Feedstock and Finished Fuel Transportation and Distribution Relative to 2016 Baseline .....	V-15
Figure V-8:	Estimated Change in NO <sub>x</sub> Emissions from Alternative Fuel Production Facilities and Petroleum-Based Projects Relative to 2016 Baseline.....	V-17
Figure V-9:	Estimated Change in PM <sub>2.5</sub> Emissions from Alternative Fuel .....	V-18
Figure V-10:	Estimated Change in NO <sub>x</sub> Emissions from Use of Alternative Jet Fuel Relative to 2016 Baseline .....	V-19
Figure V-11:	Estimated Change in PM <sub>2.5</sub> Emissions from Use of Alternative Jet Fuel Relative to 2016 Baseline .....	V-20
Figure V-12:	Estimated Statewide NO <sub>x</sub> Emissions Impact of the Proposed LCFS Amendments Relative to the LCFS at 10 Percent (tons/year) .....	V-27
Figure V-13:	Estimated Statewide PM <sub>2.5</sub> Emissions Impact of the Proposed LCFS Amendments Relative to the LCFS at 10 Percent (tons/year) .....	V-28
Figure VII-1:	Location of EV Charging Stations .....	VII-6
Figure VIII-1:	Estimated Credit Prices for the Baseline and Proposed Amendments Scenarios.....	VIII-2

Figure VIII-2: Proposed Compliance Targets under the Baseline Scenario, Proposed Amendments and Alternatives .....VIII-6

## LIST OF TABLES

Table I-1:	Proposed LCFS Schedule for Percentage Reduction in Cl.....	I-8
Table I-2:	Summary of Proposed Regulatory Amendments to the LCFS Regulation... .....	I-9
Table III-1:	Specific Purpose and Rationale for Proposed Changes to Lookup Table Pathways .....	III-83
Table III-2:	Specific Purpose and Rationale for Proposed Changes to Table 8 Temporary Pathways for Fuels with Indeterminate Cls.....	III-101
Table V-1:	2016 Baseline of Fossil and Alternative Fuel Quantities and Petroleum-Based Project Credits.....	V-4
Table V-2:	Currently Operating Petroleum Refineries in California that Produce Transportation Fuel.....	V-5
Table V-3:	Estimated 2016 California Petroleum Refining and Crude Oil Production Emissions (tons/year) .....	V-6
Table V-4:	Ethanol Facilities in California.....	V-6
Table V-5:	Reported 2015 Emissions from Ethanol Facilities in California (tons/year).. .....	V-7
Table V-6:	Biodiesel Facilities in California .....	V-7
Table V-7:	Reported 2015 Emissions from Biodiesel Facilities in California (tons/year) .....	V-8
Table V-8:	Renewable Diesel Facilities in California .....	V-8
Table V-9:	Estimated 2016 Total Emissions for Ethanol, Biodiesel, and Renewable Diesel Production in California.....	V-9
Table V-10:	Estimated 2016 Emissions for Mobile Sources in California .....	V-9
Table V-11:	Estimated Total 2016 Emissions for Transportation .....	V-9
Table V-12:	Incremental (Relative to the 2016 Baseline) Regional and Statewide Avoided Mortality and Morbidity Incidences from 2019 to 2030 under the Proposed Amendments Scenario .....	V-25
Table VI-1:	Summary of Potential Environmental Impacts .....	VI-2
Table VIII-1:	Range of Proposed Amendments Cost Pass Through .....	VIII-4
Table XI-1:	LCFS Public Workshops and Topic-Specific Working Meetings .....	XI-2

## Executive Summary

### Purpose of Proposed Rulemaking

In this rulemaking, the California Air Resources Board (Board or CARB) staff is proposing to amend the Low Carbon Fuel Standard (LCFS) regulation. Since the Board's original adoption of the LCFS in 2009, the basic framework of the program has worked well and the use of alternative fuels with low greenhouse gas (GHG) performance is becoming widespread throughout California.

Before the LCFS, the only alternative fuels for transportation with any significant market share were natural gas and ethanol. Between the first year of LCFS compliance (2011) and 2016, a wide variety of low carbon fuels proved their commercial feasibility and began to be deployed in large volumes. In the most recent quarter for which LCFS data are available (Q3 2017), the carbon intensity (CI) of all transportation fuels used in the state has decreased 3.7 percent relative to a 2010 baseline, generating nearly 2.5 million metric tons (MT) of LCFS credits.<sup>1</sup> During this quarter, biomass-based diesel averaged 14 percent of every gallon of diesel sold in the state; renewable natural gas was 68 percent of all fuel used in natural gas vehicles; and ethanol, electricity<sup>2</sup> and hydrogen used in passenger vehicles displaced 303 million gallons of gasoline.

In 2016, the California legislature adopted Senate Bill (SB) 32 (Pavley, 2016), which codifies a statewide GHG target of at least 40 percent below 1990 levels by 2030. In December of 2017, the Board adopted a strategy for achieving this target known as *California's 2017 Climate Change Scoping Plan* (Scoping Plan). The Scoping Plan made it clear that developing a more ambitious LCFS is a critical part of the state's efforts to achieve the SB 32 goal and to:

- Lower GHG emissions on a trajectory to avoid the worst impacts of climate change;
- Support a clean energy economy which provides more opportunities for all Californians;
- Reduce our reliance on fuels derived from petroleum;
- Advance the necessary technologies to achieve deep decarbonization across the Californian economy in the long run.

This rulemaking will set ambitious targets for low carbon fuel use from the transportation sector—the proposed amendments target a 20 percent reduction in fuel CI from a 2010 baseline by 2030. Staff's proposed amendments will also improve the efficiency of the program—reducing application time, streamlining and further clarifying reporting

---

<sup>1</sup> As described in more detail below, carbon intensity is a measure of the GHG emissions associated with the various production, distribution, and consumption steps in the "life cycle" of a transportation fuel.

<sup>2</sup> The electricity data include staff's projected estimates for non-metered residential charging which is off-cycle relative to the other credit generation in the LCFS system.

requirements, creating additional flexibility for program participants, and creating more opportunities for low carbon fuel providers.

## **Background and Program Overview**

The LCFS program uses life cycle assessment (LCA) to examine the GHG emissions associated with the production, distribution, and end use of all transportation fuels used in California. The carbon intensity scores assessed in the LCFS to each fuel are compared to a declining CI benchmark for each year. Low carbon fuels below the benchmark generate credits. Fuels above the CI standard generate deficits.

Each year, a supplier of fuel must match all deficits created from supply of high carbon fuels with credits associated with the supply of low carbon fuel. A tradeable system for these credits ensures entities who do not choose to make low carbon fuel themselves can fund the production of low carbon fuels by other program participants.

Credits in 2016 were generated primarily from ethanol (39 percent), renewable diesel (24 percent), biodiesel (19 percent), and to a lesser—but growing—extent, from biomethane (seven percent) and electricity (nine percent). Credit prices and trading activity reached all-time highs in 2017. Over five million LCFS credits were sold or traded in approximately 929 transactions in 2016 with an average credit price of \$101/metric ton carbon dioxide equivalent (CO<sub>2</sub>e), demonstrating a robust credit market.

Many of the alternative fuels that have low carbon intensity also have one or more of the following co-benefits: (1) improved performance with respect to conventional air pollutants, (2) the ability to be used in efficient advanced vehicles, which leads to fuel savings, and (3) reduced petroleum dependency, such that California consumers have more fuel choices and are less exposed to fluctuations in world oil prices.

## **Summary of Proposal**

### 2019 through 2030 Carbon Intensity Decline

The most significant change under consideration in this rulemaking is how to strengthen the CI reduction targets through 2030 in-line with the SB 32 goals. The proposed amendments target a 20 percent reduction in fuel carbon intensity (CI) from a 2010 baseline by 2030. The amendments also propose smoothing the near-term benchmark schedule by linearly reducing by 1.25 percent annually from a 5 percent reduction in 2018 to the 20 percent value in 2030.

Increasing the stringency of the LCFS carbon intensity targets is necessary to achieve California's 2030 GHG target. The 2017 Scoping Plan considered an 18 percent reduction target for 2030. After the conclusion of the Scoping Plan analysis, staff solicited additional stakeholder feedback through LCFS workshops. Based on stakeholder data received in these LCFS workshops and staff's additional analysis of



possible compliance scenarios building off the Scoping Plan analytics, staff believes that a 20 percent by 2030 CI target is achievable and appropriate.

Staff is also recommending smoothing the CI trajectory by adjusting the benchmarks for years 2019 through 2021. Figure EX-1 shows staff’s proposed benchmarks as compared to the benchmarks in the current regulation for years 2015 through 2030. All else equal, staff’s proposal achieves additional long-run GHG reductions while reducing the probability of unnecessarily high short-run credit prices, which staff’s analysis indicated may occur if the current regulation’s benchmarks are retained.

**Figure EX-1: Current and Proposed Annual Carbon Intensity Benchmarks as Compared to CI Reductions Achieved in 2017 by the Most Common Alternative Fuels**



\* Negative CIs have been achieved for some fuel pathways but are not shown.

\*\* The average percent CI reduction for electricity shown represents Light-Duty Electric Vehicle charging.

### Changes to Fuels Subject to the Regulation

Staff is proposing amendments that would broaden the list of fuels subject to the LCFS regulation and alter the opt-in and/or exempt status of particular fuels. The major potential changes include:

- The addition of alternative jet fuels (AJF) as opt-in credit-generating fuels:** Including AJF in the LCFS may result in several benefits. First, incorporating AJF would clearly signal California’s interest in addressing a significant and growing source of GHG emissions. Currently, GHG emissions from aviation contribute to approximately two percent of the total global emissions and are expected to grow. Second, because AJF and renewable diesel (RD) are often produced in

the same facility using the same feedstock, inclusion of AJF may lead to increased investment in facilities, thereby increasing the production of both alternative fuels. The airline industry is developing a strong record for partnering with alternative fuel producers through direct investment and off-take agreements.

- **Removing the opt-in status for fossil compressed natural gas (CNG), hydrogen, and the exemption for propane:** In the current regulation, hydrogen and CNG from fossil natural gas are opt-in fuels because they are presumed to have a CI that meets the benchmarks in every year. As staff is proposing more ambitious CI benchmarks, however, staff anticipates some pathways for these fuels will have a CI that exceeds the benchmarks and become deficit-generating fuels. Liquefied petroleum gas (LPG or “propane”), including renewable propane, is exempt from the current regulation, meaning its use as a transportation fuel generates neither credits nor deficits. Staff is proposing to include this fuel in the LCFS.
- **Allowing alternative fuels used in military vehicles to opt in:** The LCFS currently exempts all fuels supplied for use in military tactical vehicles and support equipment from both credit and deficit generation. Producers of renewable fuels used in these applications have expressed concern that this provision reduces their incentives to sell low carbon fuels to the military. These producers have requested opt-in status for the alternative fuels sold for use in these military applications. Staff is supportive of this approach because it simplifies the decision-making framework created by the LCFS for low carbon fuel producers.

#### Carbon Capture and Sequestration Protocol

Carbon Capture and Sequestration (CCS) is a potentially significant technology for reducing CO<sub>2</sub> emissions from large stationary sources. In light of California’s mid- and long-term climate goals, CCS is likely to grow in importance. In the 2015 LCFS rulemaking, CARB clarified that CCS projects would be eligible to produce LCFS credits upon the adoption of a Board-approved quantification methodology (QM) and relevant regulatory requirements that ensure sequestration permanence. The proposed amendments in this rulemaking include a fully developed CCS Protocol.

#### Promote Zero Emission Vehicle Infrastructure and Renewable Electricity to ZEVs

Staff is proposing amendments that expand opportunities for accounting for renewable/low-CI electricity used in zero emission vehicle (ZEV) applications, such as electric vehicle charging and hydrogen production via electrolysis. Electricity is the primary—if not the sole—factor in determining the CI of these fuel pathways and the combination of renewable electricity and ZEVs offers significant opportunity for CI reductions.

However, we have seen very little interest in such pathways under the current rule. Staff believes that the lack of fuel pathways that combine zero carbon electricity and ZEV fueling technology is due to the small geographic footprint of ZEV infrastructure—which is often located in dense urban areas—making it difficult to co-locate renewable power generation with fueling stations.

To address this issue, staff proposes to allow renewable power generated in the same balancing authority as the ZEV load to be used in EV charging and H<sub>2</sub> production. Staff's goal is to incent the installation of additional low carbon electricity supply coupled with additional ZEV fueling infrastructure. Staff modelled these amendments off the existing flexibility for renewable natural gas used in natural gas vehicles—the main other alternative fuel that requires new fueling infrastructure.

Additionally, staff is proposing an option to recognize and reward the GHG benefits of shifting EV charging and electrolytic hydrogen load to the periods of time when intermittent renewable electricity might otherwise be wasted (curtailed). These amendments would allow the LCFS to increase its effectiveness as a tool for promoting the integration of renewable power and ZEV-related load and help make these vehicles truly “zero emission” on a life cycle basis.

These amendments are intended to promote the expansion of zero-emission vehicle infrastructure through the Low Carbon Fuel Standard Program as directed by Executive Order B-48-18.<sup>3</sup>

### Improve Crediting for Innovative Actions at Conventional Fuel Refineries

The 2015 LCFS rulemaking introduced a pilot program for crediting conventional petroleum refineries for GHG reduction projects performed within the boundary of the refinery. The current Refinery Investment Credit Pilot Program (RICPP) allows refineries to generate credits for projects that reduce refinery GHG emissions by at least 0.1 grams carbon dioxide equivalent per mega joule (gCO<sub>2</sub>e/MJ), calculated based on pre- and post-project GHG emissions at the refinery level. To date the LCFS program has not issued any credits under this provision, in part due to the uncertainty of the eligibility threshold and credit calculation using the refinery's entire emissions, which fluctuate due to confounding factors beyond the impacts of the project in question.

Staff is proposing to make changes to the RICPP with the goals of: (1) focusing the provision on innovative changes at refineries, (2) simplifying the eligibility threshold and credit calculation method by focusing on project-level rather than refinery-wide emission changes.<sup>4</sup> Example of innovative projects that would be eligible under the proposed amendments include carbon capture and sequestration, the use of renewable electricity,

---

<sup>3</sup> Available at <https://www.gov.ca.gov/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/>

<sup>4</sup> Staff is proposing a new eligibility threshold whereby the GHG reduction in project life cycle emissions would need to be at least one percent of to the pre-project on-site refinery level GHG emissions.

fossil fuel substitution by renewable fuels for process energy, and electrification. Focusing this provision on innovative technologies would align it with the more successful provision for crediting production of crude using innovative methods and the overall technology-advancement goals at the core of the LCFS.

Relative to the current provision, these amendments would clearly signal the types of technological changes CARB would like to see the conventional petroleum refineries adopt. Simultaneously it will make the eligibility threshold more achievable, easier to estimate, and equitable to all refineries.

#### Addition of Third-party Verification

A successful GHG reduction program requires a system to monitor, report, and verify GHG emissions to support implementation and tracking of the effectiveness of emission reduction strategies. To date, the LCFS has relied upon a robust reporting program that includes CARB staff evaluation of fuel CI during the fuel pathway application process and audits of the reporting of quarterly fuel quantities. Staff is now proposing to supplement the work of CARB staff with a verification system that would require regulated entities reporting to CARB under the LCFS to retain the services of independent third-party verifiers. LCFS verifiers would perform GHG accounting checks in a role similar to the independent, objective evaluations of organizations' financial reports by financial auditors.

#### Pathway Application and CI Determination

Staff is proposing changes to the CI pathway application and certification process to better integrate with the system for third-party verification discussed above. Staff expects these changes would reduce application preparation time by the applicant as well as evaluation and processing time by CARB. Our goal is to enhance transparency and simplicity of CI calculations while ensuring accuracy of raw data inputs and basic pathway information through independent third-party verification.

#### *Adjust ADF Biodiesel in-use NOx Mitigation Sunset to Ensure Long Term NOx Mitigation*

On July 15, 2013, the State of California Court of Appeal, Fifth Appellate District (Court) issued an opinion in *POET, LLC versus California Air Resources Board* (2013) 218 Cal.App.4th 681. The Court held that CARB needed to remedy California Environmental Quality Act (CEQA) and Administrative Procedure Act (APA) issues, relating to the adoption of the original LCFS, including concerns about CARB's analysis of the environmental impacts of biodiesel.

CARB readopted the LCFS in 2015 to address the Court's concerns. At the same hearing, the Board also adopted the Alternative Diesel Fuels (ADF) regulation. The ADF regulation imposed restrictions to prevent certain biodiesels, which LCFS might incent, from causing any significant new emissions. A 2017 Court of Appeal opinion

concluded that CARB, in the 2015 re-adoption, had failed to adequately analyze potential NOx impacts that may have been caused by increased use of biodiesel driven by the LCFS. On October 18, 2017, the Superior Court issued a writ of mandate pursuant to the direction of the Court of Appeal.

In response to this writ of mandate, CARB set aside the portions of the 2015 LCFS environmental analysis addressing NOx emissions from biodiesel on November 17, 2017, and has developed a supplemental environmental analysis to the 2015 Environmental Analysis to more comprehensively address potential LCFS-driven biodiesel NOx emissions impacts. A draft of that supplemental analysis is included as Appendix G to this Staff Report.

Based on this updated analysis, staff proposes to add an additional requirement to the sunset provision of the ADF regulation such that the ADF sunset would not occur for biodiesel until the hours of operation of off-road New Technology Diesel Engines (NTDEs) are 90 percent of the total hours of operation of off-road diesel engines. This is in addition to the current provision requiring 90 percent of vehicle miles travelled by on-road heavy-duty diesel vehicles to be from on-road heavy-duty NTDEs.

## **Potential Impacts of the Proposal**

### Potential Environmental Impacts

The existing LCFS regulation, established in previous rulemakings, defines the current requirements for the CI of fuels in California. CEQA states the baseline for determining the significance of environmental impacts will normally be the existing conditions at the time the environmental review is initiated. Therefore, significance determinations reflected in the Draft EA are based on a comparison of the potential environmental consequences of the proposed LCFS amendments with the LCFS at the 2016 regulatory standards.

Cumulatively, from 2019 through 2030, staff expects the proposed amendments to achieve 70 MMT CO<sub>2</sub>e additional GHG reductions beyond a business-as-usual scenario in which the current regulation is not amended.<sup>5</sup>

The proposed amendments are also expected to result in slight improvements to California's statewide air quality relative to both the current (2016) conditions and relative to the business-as-usual scenario. The total statewide NOx and PM<sub>2.5</sub> emissions are estimated to be lower in each year from 2019 through 2030 as the result

---

<sup>5</sup> CEQA states the baseline for determining the significance of environmental impacts will normally be the existing conditions at the time the environmental review is initiated. Therefore, significance determinations reflected in the Draft EA are based on a comparison of the potential environmental consequences of the proposed amendments with the existing regulatory setting and physical conditions in 2016. However, to provide additional context and transparency in some portions of this ISOR staff also compares the impacts of the amendments to a scenario where the current regulation is retained and changes result from the current conditions (a "business as usual" scenario).

of the amendments. The annual NO<sub>x</sub> and PM<sub>2.5</sub> emission reductions represent less than one percent of total statewide emissions.

For the purpose of determining whether the proposed regulations have a potential adverse effect on other aspects of the environment, CARB evaluated the potential physical changes to the environment resulting from a reasonable foreseeable compliance scenario for the proposed LCFS amendments. The environmental effects of the proposed LCFS amendments would build upon the compliance responses of the current LCFS regulation. In many instances, compliance responses associated with the proposed LCFS amendments would be an intensification of actions that are already occurring.

Given the small magnitude of the statewide criteria pollutant improvements in staff's scenarios, and the complexity of compliance responses to the LCFS, local air quality increases in some local jurisdictions cannot be ruled out. Because the authority to determine project-level impacts and required project-level mitigation lies with land use and/or permitting agencies for individual projects, and the programmatic level of analysis associated with the Draft EA does not attempt to address project-specific details of mitigation, there is inherent uncertainty in the degree of mitigation that may ultimately be implemented.

Consequently, while impacts could be reduced to a less-than-significant level by land use and/or permitting agency conditions of approval, the Draft EA takes the conservative approach in its post-mitigation significance conclusions and discloses, for CEQA compliance purposes, that impacts from the development of new facilities or modification of existing facilities associated with reasonably foreseeable compliance responses to the proposed LCFS regulation could be potentially significant and unavoidable.

The Draft EA concluded implementation of these proposed LCFS amendments could result in the following short-term and long-term beneficial and adverse impacts: beneficial impacts to energy demand and greenhouse gases; less-than-significant impacts to cultural resources, energy demand, greenhouse gases, hazards and hazardous materials, mineral resources, population employment, and housing, public services, and recreation; and potentially significant and unavoidable adverse impacts to aesthetics, agriculture and forest resources, air quality, biological resources, cultural resources, energy demand, geology and soils, hazards and hazardous materials, hydrology and water quality, land use and planning, mineral resources, noise, transportation/traffic and utilities and service systems. The potentially significant and unavoidable adverse impacts are primarily related to short-term, construction-related activities. This explains why some resource areas are identified above as having both less-than-significant impacts and potentially significant impacts. Please refer to the Draft EA for further details.

## Potential Economic Impacts

The LCFS has a range of potential economic impacts. They include direct costs to high carbon fuel producers, which are described below, and a broader set of macroeconomic impacts across California's economy. For example, the LCFS supports the growth of businesses and industries in California and elsewhere that are supplying lower carbon fuels, including renewable natural gas, advanced biofuels and others.

The LCFS also has interactive effects with other policies, for example it reduces compliance costs under California's Cap-and-Trade program for fuel sold by regulated entities that are subject to both regulations. Conversely, ZEVs sales are strongly promoted by the Advanced Clean Car package of rules, and the sale of these vehicles makes low carbon fuel use more likely. Similarly, the federal Renewable Fuels Standard creates a strong incentive for the use of some fuels that the LCFS also rewards. Because the impact of these interacting incentives are at times difficult to disentangle quantitatively, staff has endeavored to explain these interaction effects and to adopt a straightforward method to attribute abatement actions either to the LCFS or to other policies for the purpose of economic and air quality analyses.

### *Cost and Benefits to Regulated Parties*

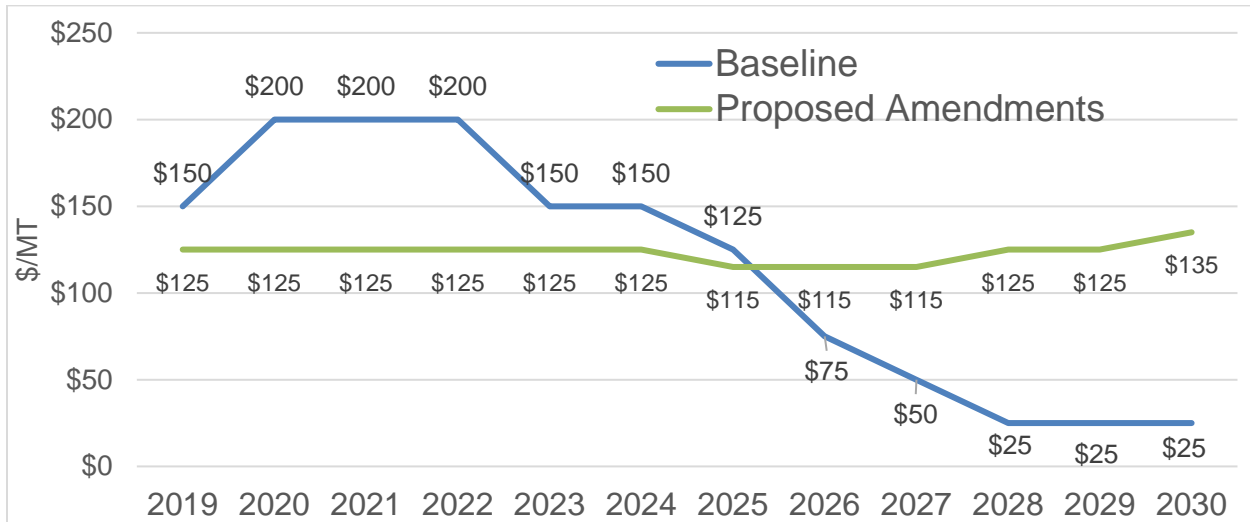
Staff believes the proposed CI benchmark schedule is more likely to produce strong and stable incentives for long-term decarbonization of California's transportation fuels.<sup>6</sup>

Figure EX-2 shows the estimated credit price for the projected baseline and proposed amendments scenarios from 2019 through 2030. Staff's analysis establishes the LCFS credit price for each scenario using the cost of obtaining the marginal (most expensive) credit in a given year. Given the high-level of uncertainty related to marginal abatement each year, these prices should be treated as illustrative rather than predictive. The availability of new lower-cost pathways, such as credit generation from alternative jet fuels and CCS projects, and the reduction trajectory being more closely aligned with the turnover of the vehicle fleet to alternative fuel vehicles, are expected to increase the likelihood of long-term stable LCFS credit prices under the proposed amendments.

---

<sup>6</sup> Prices are expected to decrease in the short-run but increase in the long-run due to the smoother near-term benchmarks and long-run ambition of the proposed amendments.

**Figure EX-2: Estimated Credit Prices for the Baseline and Proposed Amendments Scenarios**



The proposed amendments are projected to go into effect in 2019. From 2019 through 2030, the proposed amendments to the LCFS are estimated to result in total direct costs to deficit generators of about \$9.0 billion. The highest annual cost occurs in 2030 with an estimated direct cost of \$3.7 billion.

From 2019 through 2030, the proposed amendments to the LCFS are estimated to result in a decrease in the direct costs (i.e. an increase in revenue) to California credit generators of about \$3.8 billion. Many of California’s biodiesel producers, hydrogen producers, electric charging stations, hydrogen stations, and natural gas stations are small businesses who will benefit from these amendments.

*Macroeconomic Effects*

For a major regulation proposed on or after January 1, 2014, a standardized regulatory impact analysis (SRIA) is required. A major regulation is one “that will have an economic impact on California business enterprises and individuals in an amount exceeding fifty million dollars (\$50,000,000), as estimated by the agency.” (Govt. Code Section 11342.548). The LCFS amendments were determined to be a major regulation; therefore, CARB prepared a SRIA and submitted it to the Department of Finance (DOF) in November of 2017. DOF provided feedback and CARB staff have updated the SRIA and responded to DOF’s comments as shown in Appendix E of this ISOR.

The macroeconomic impacts of the proposed amendments are negligible, considering the size and diversity of California’s economy. As one example, Gross State Product is the market value of all goods and services produced in California and is one of the primary macroeconomic indicators used to gauge the health of an economy. Under the proposed amendments, GSP is anticipated to have an average growth rate of 2.4 percent per year. Under the proposed amendments, GSP growth is estimated to be



slightly faster, relative to the baseline, from 2019-2025 and then slightly slower from 2026-2030.<sup>7</sup> CARB interprets the impact of the proposed amendments on GSP as being indiscernible in California's \$3.4 trillion economy in 2030.

### *Other Highlighted Benefits*

CARB anticipates that the proposed amendments, including the CI reductions outlined in Figure EX-1, will have the following general benefits to California businesses and individuals:

- **Reduced GHG emissions.** The LCFS is specifically designed to reduce GHG emissions in the transportation sector, which is responsible for nearly half of GHG emissions in California. This will contribute to California's efforts to address climate change. If all GHG reductions under the proposed amendments are assumed to be carbon dioxide reductions, in 2030 the estimated benefits from the proposed amendments would range from approximately \$555 million to \$2.5 billion (in 2016\$).
- **Increased use of lower CI alternative fuels** and alternative fueled vehicles including biodiesel, renewable diesel, renewable jet fuel, low NO<sub>x</sub> natural gas trucks, and electric and hydrogen zero emission vehicles. In addition to reducing GHG emissions, this will lower levels of localized air pollutants, which are the cause of many deleterious health effects on California residents. As modeled, the proposed amendments would reduce PM<sub>2.5</sub> and NO<sub>x</sub> emissions, resulting in cumulative health benefits for individuals in California of approximately \$900 million over the period of 2019 to 2030 relative to business-as-usual. The value of these health benefits are due to fewer instances of premature mortality, fewer hospital and emergency room visits, and fewer lost days of work.
- **Greater opportunities for California businesses to invest** in the production of alternative fuels and other credit generating opportunities at oil fields and refineries.
- **Reduced dependence on fossil fuel and crude oil imports** and diversification of the transportation fuel pool, which may decrease the exposure of California to large swings in energy prices due to external economic shocks.

---

<sup>7</sup> All of these GSP variations are less than 0.1% of a change from the baseline on an annual basis.

Some of these benefits are beyond the scope of staff's analysis in this rulemaking, but some studies suggest they are significant.<sup>8,9,10,11,12</sup>

Furthermore, while the LCFS is designed to increase the supply of alternative fuels in California and drive existing supply chains to reduce emissions, perhaps a larger measure of its impact is evidenced by the development of similar programs, using a life cycle GHG performance-based approach, in other jurisdictions. Oregon and British Columbia have implemented similar regulations, and such programs are also under consideration at the national level in Brazil<sup>13</sup> and Canada.<sup>14</sup>

---

<sup>8</sup> Petroleum Market Advisory Committee, California Energy Commission, September 2017. Available at: [http://docketpublic.energy.ca.gov/PublicDocuments/15-PMAC-01/TN221306\\_20170925T092536\\_Petroleum\\_Market\\_Advisory\\_Committee\\_Final\\_Report.pdf](http://docketpublic.energy.ca.gov/PublicDocuments/15-PMAC-01/TN221306_20170925T092536_Petroleum_Market_Advisory_Committee_Final_Report.pdf)

<sup>9</sup> National Research Council, Transitions to Alternative Vehicles and Fuels. (2013) National Academy of Sciences. Available at: [http://www.nap.edu/catalog.php?record\\_id=18264](http://www.nap.edu/catalog.php?record_id=18264)

<sup>10</sup> Fine, J., et al. The upside hedge value of California's global warming policy given uncertain future oil prices. Energy Policy (2012) doi 10.1016/j.enpol.2012.01.010

<sup>11</sup> Greene, D.L., Roderick, S.L., Hopson, J.L. OPEC and the Costs to the U.S. Economy of Oil Dependence: 1970-2010, (2013) Howard H. Baker Jr. Center for Public Policy.

<sup>12</sup> Greene, D.L., Tishchishyna, N.I. Costs of Oil Dependence: A 2000 Update. (2000) Oak Ridge National Laboratory.

<sup>13</sup> Temer sanctions incentive policy for biofuels. BrazilGovNews, Federal Government of Brazil. December 28, 2017. <http://www.brazilgovnews.gov.br/news/2017/12/temer-sanctions-incentive-policy-for-biofuels>

Brazil to Launch Ambitious Biofuels Program. Ethanol Producer Magazine. November 17, 2017 <http://ethanolproducer.com/articles/14803/brazil-to-launch-ambitious-biofuels-program>

<sup>14</sup> Environment and Climate Change Canada. Clean Fuel Standard Discussion Paper. February 2017. [http://ec.gc.ca/lcpe-cepa/D7C913BB-13D0-42AF-9BC7-FBC1580C2F4B/CFS\\_discussion\\_paper\\_2017-02-24-eng.pdf](http://ec.gc.ca/lcpe-cepa/D7C913BB-13D0-42AF-9BC7-FBC1580C2F4B/CFS_discussion_paper_2017-02-24-eng.pdf)

## **I. INTRODUCTION AND BACKGROUND**

In this chapter, the California Air Resources Board (CARB or Board) staff provides a brief overview of the Low Carbon Fuel Standard (LCFS), information on the history and current status of the LCFS program, and an overview of the proposed revisions to the program.

The Board approved the LCFS regulation in 2009 as a discrete early action measure under the California Global Warming Solutions Act of 2006 (AB 32). The purpose of the LCFS regulation is to reduce the carbon intensity of transportation fuels used in California, thereby reducing greenhouse gas (GHG) emissions, and to diversify the fuel pool to enable long-term dramatic decarbonization of the transportation sector. The regulation provides co-benefits in addition to these primary objectives, as discussed in this Staff Report.

Through this proposed rulemaking to amend the regulation, staff seeks to strengthen the LCFS targets. In 2016, the California legislature adopted Senate Bill (SB) 32 (Pavley, 2016), which codifies a statewide GHG target of at least 40 percent below 1990 levels by 2030. To encourage additional GHG reductions in key areas where decarbonization will be important to meet long-term climate goals, staff proposes to recognize eligibility of new fuels and vehicle applications for generating credits under the program. To enhance the integrity of the emission reduction claims in the program, the amendments include a proposal to establish an independent third-party verification and verifier accreditation program for ensuring the accuracy of data reported under LCFS. Finally, the proposed amendments include a number of changes that would integrate the verification system, update program data, quantification methods and analysis tools, and other changes to improve, streamline, and further clarify application and reporting processes.

### **A. Overview of the LCFS**

Transportation plays a key role in California's economy and lifestyle. The production and use of traditional petroleum-derived transportation fuels—such as gasoline and diesel—is responsible for almost half of the State's GHG emissions. The LCFS is a key part of a comprehensive set of California programs to cut GHG emissions by improving vehicle technology, reducing fossil fuel consumption, and implementing sustainable land-use policies.<sup>15</sup> The LCFS is designed to decrease the carbon intensity (CI) of California's transportation pool and provide an increasing range of low-carbon and renewable alternatives to conventional petroleum-derived fuels.<sup>16</sup>

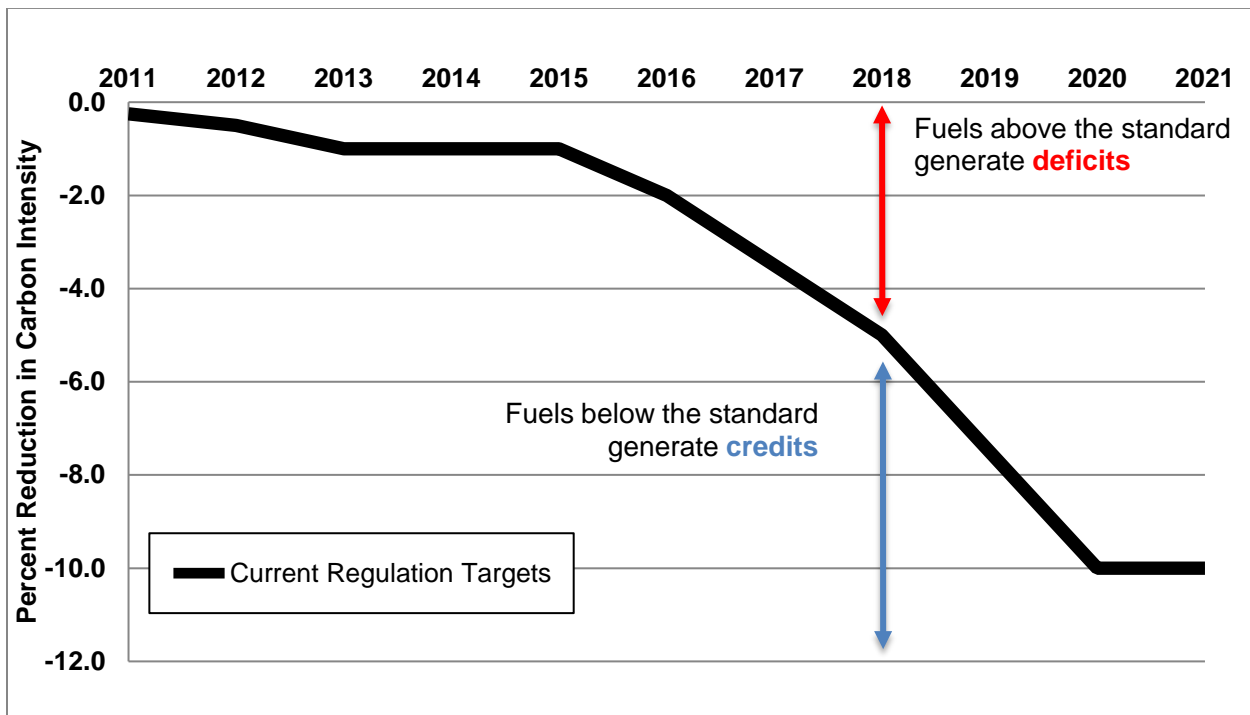
---

<sup>15</sup> The Climate Change Scoping Plan explains the overarching framework of California's GHG policies. The current Draft 2017 Climate Change Scoping Plan Update is available from: <https://www.arb.ca.gov/cc/scopingplan/scopingplan.htm>

<sup>16</sup> Carbon intensity (CI) is a measure of the GHG emissions associated with the various production, distribution, and consumption steps in the "life cycle" of a transportation fuel.

Providers of transportation fuels must demonstrate that the mix of fuels they supply for use in California meets the LCFS carbon intensity standards, or benchmarks, for each annual compliance period. They must report all fuels provided, and track the fuels' carbon intensity through a system of "credits" and "deficits." Credits are generated by supplying fuels with lower carbon intensity than the benchmark. Deficits result from supplying fuels with higher carbon intensity than the benchmark. This concept is illustrated in Figure I-1. A deficit generator meets its compliance obligation by ensuring that the amount of credits it earns or otherwise acquires from another party is equal to, or greater than, the deficits it has incurred. Credits and deficits are generally determined based on the quantity of fuel sold, the carbon intensity of the fuel, and the efficiency by which a vehicle converts the fuel into useable energy. Additionally, there are CARB-approved LCFS project-based actions that may generate credits, such as by demonstrating carbon capture and sequestration, using solar-generated steam at oil and gas extraction sites, and investing in refinery improvements that reduce emissions. Credits and deficits are denominated in metric tons of GHG emissions. Credits may be banked and traded within the LCFS market to meet compliance obligations.

**Figure I-1: Illustration of LCFS Mechanics: How Credits and Deficits are Calculated**



The LCFS carbon intensity benchmarks are an annually-declining standard, which are defined in the LCFS regulation as a percentage reduction from the historical average carbon intensity of gasoline and diesel fuel in the year 2010. To determine the carbon intensity value of a particular fuel, the GHG emissions from all steps in the fuel's life cycle are summed and divided by the fuel's energy content (in megajoules). GHG emissions from each step can include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous

oxide (N<sub>2</sub>O), volatile organic compounds (VOC) and carbon monoxide (CO), which are adjusted by their Intergovernmental Panel on Climate Change (IPCC) global warming potentials to their CO<sub>2</sub> equivalent. Thus, carbon intensity is expressed in terms of grams of CO<sub>2</sub> equivalent per megajoule (gCO<sub>2</sub>e/MJ).

The LCFS is based on the principle that each fuel has life cycle GHG emissions. This life cycle analysis (LCA) examines the GHG emissions associated with the production, transportation, and use of a given fuel. The LCA includes direct emissions from the energy and material inputs to production, transport, and use of the fuels, as well as significant GHG emissions from market-driven changes, such as changes in land use for some crop-derived biofuels, and emissions that may result from market displacement effects (e.g., when a material is diverted from its historic use in order to produce a fuel, causing increased demand for another material to substitute the for fuel feedstock). The system of declining benchmarks that is used to calculate credits and deficits, and the obligation of deficit-generating fuels to be canceled out by credits, result in a decrease in the total life cycle GHG emissions from the transportation fuel pool in California.

The LCFS is designed to encourage the use of low carbon fuels in California, to encourage the lowest-carbon production of those fuels in California and elsewhere, thereby, reducing GHG emissions and advancing the technology underlying these low carbon fuels. The LCFS is performance-based and the flexibility of the credit market allows many possible low carbon fuels to contribute to the carbon intensity reductions.

A more complete description of how the LCFS regulation is designed to work, as well as its underlying scientific and economic principles, can be found in the initial and final statements of reasons for the original 2009 rulemaking,<sup>17</sup> the 2011 and 2015 Staff Reports.<sup>18,19</sup>

---

<sup>17</sup> See "Staff Report: Initial Statement of Reasons: Proposed Regulation to Implement the Low Carbon Fuel Standard." March 5 (2009); Staff Report: Initial Statement of Reasons: Proposed Regulation to Implement the Low Carbon Fuel Standard Volume II." March 5 (2009); and "Final Statement of Reasons for Rulemaking, Including Summary of Public Comments and Agency Responses." December (2009). Available at: <https://www.arb.ca.gov/regact/2009/lcfs09/lcfs09.htm>.

<sup>18</sup> See "Staff Report: Initial Statement of Reasons for Rulemaking: Proposed Amendments to the Low Carbon Fuel Standard." October 26 (2011); and "Final Statement of Reasons: Amendments to the Low Carbon Fuel Standard Regulation." October 11 (2012). Available at: <https://www.arb.ca.gov/regact/2011/lcfs2011/lcfs2011.htm>.

<sup>19</sup> See "Staff Report: Initial Statement of Reasons for Rulemaking: Proposed Re-adoption of the Low Carbon Fuel Standard Regulation." December 31 (2014); and "Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Response: Re-adoption of the Low Carbon Fuel Standard Regulation." October 2 (2015). Available at: <https://www.arb.ca.gov/regact/2015/lcfs2015/lcfs2015.htm>.

## **B. History and Current Status of the LCFS**

CARB initially approved the LCFS regulation in 2009. Throughout the nearly eight years since the Board's original adoption, the basic framework of the current LCFS—including the use of life cycle analysis, the LCFS credit market, and the electronic registry for fuel reporting—has worked well and continues to support growth in an increasingly diverse and low-carbon transportation fuel pool.<sup>20</sup>

CARB approved revisions to the LCFS in December 2011, which became effective on November 26, 2012, and were implemented by CARB on January 1, 2013. On July 15, 2013, the State of California Court of Appeal, Fifth Appellate District (Court) issued its opinion in *POET, LLC versus California Air Resources Board* (2013) 218 Cal.App.4th 681, resulting in a stay of the LCFS. The Court held that the LCFS adopted in 2009 and implemented in 2010 (referred to as 2010 LCFS) would remain in effect and that CARB could continue to implement and enforce the 2013 regulatory standards while taking steps to remedy California Environmental Quality Act (CEQA) and Administrative Procedure Act (APA) issues as required in the ruling.

To address the court ruling, CARB brought a revised LCFS regulation to the Board for re-adoption in February 2015. The 2015 rulemaking included many amendments, updates and improvements to the program, including a compliance schedule that maintained the 2009 LCFS regulation's target of a 10 percent reduction in average carbon intensity by 2020 from a 2010 baseline. On September 24, 2015, the Board approved the current LCFS regulation. The current regulation became effective on January 1, 2016.<sup>21</sup>

When readopting the LCFS in 2015 the Board also adopted the Alternative Diesel Fuels (ADF) regulation, clarifying an approval process for such fuels. The ADF regulation also imposed restrictions to prevent certain biodiesels from causing any significant new emissions.

After the Fresno County Superior Court initially discharged the writ of mandate directing CARB to take corrective action pursuant to the 2013 Court of Appeal ruling in January 2016, the Court of Appeal reversed the discharge of the writ of mandate in a May 30, 2017 opinion. (*POET, LLC v. California Air Resources Board* (2017) 12 Cal.App.5th 52, 58 (as modified).) The 2017 Court of Appeal opinion concluded that CARB had failed to adequately analyze potential NOx impacts that may have been caused by increased use of biodiesel driven by the LCFS. On October 18, 2017, the Superior Court issued a writ of mandate pursuant to the direction of the Court of Appeal. In response to this writ of mandate, CARB set aside the portions of the 2015 LCFS environmental analysis addressing NOx emissions from biodiesel on November 17, 2017, and has developed supplemental environmental analysis to more comprehensively address potential LCFS

---

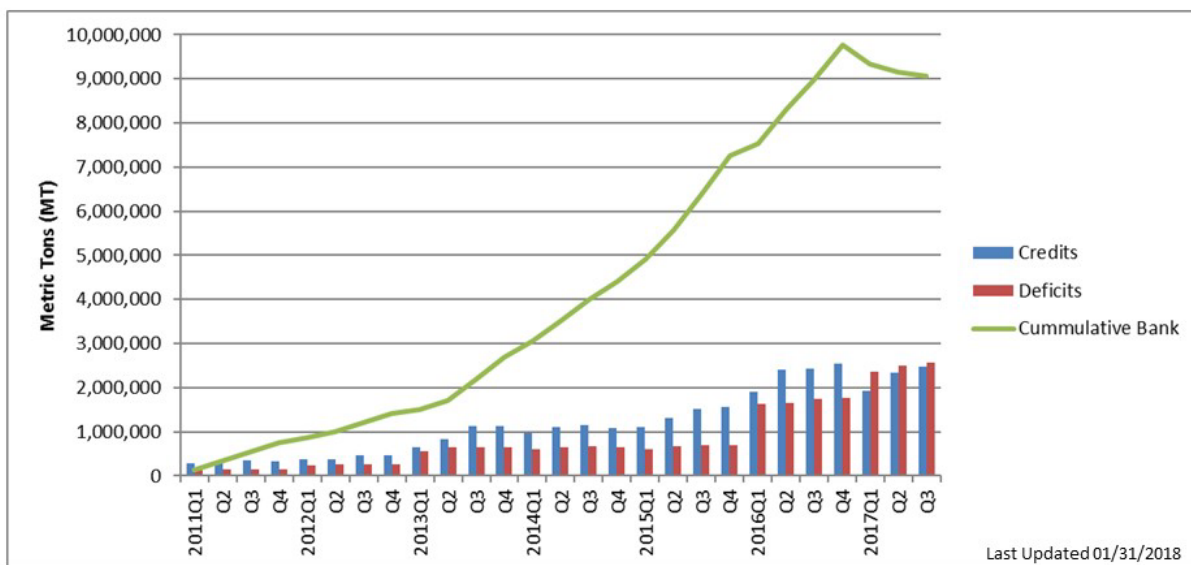
<sup>20</sup> Staff presented a progress report on the LCFS program to the Board on June 22, 2017. Available at: <https://www.arb.ca.gov/board/books/2017/062217/17-6-4pres.pdf> The record created in this rulemaking fulfills the requirement to conduct a program review in section 95496(b) of the current regulation.

<sup>21</sup> Title 17, California Code of Regulations (CCR), sections 95480-95497.

biodiesel NOx emissions impacts. A draft of that supplemental analysis is included as Appendix G to this ISOR. From the results of that supplemental analysis, staff's proposed amendments now include a proposed amendment to the ADF sunset provision designed to create greater certainty with respect to mitigation of potential future NOx emissions impacts from biodiesel use in off-road diesel engines. The writ of mandate orders CARB to maintain the 2017 LCFS CI reduction level for diesel and diesel substitutes until the writ is discharged.

Through the end of 2016 (the most recent full data year available), California had achieved a reduction of more than 2.5 percent in the average carbon intensity of the overall transportation fuel pool, as compared to a target reduction of 2 percent. Regulated parties have historically over-complied with the regulation, providing a bank of about nine million excess credits that are available for future compliance, as shown in Figure I-2. The financial benefits are distributed among providers of various alternative fuels (as illustrated in Figure I-3), geographically across California,<sup>22</sup> and across the participating credit generators.<sup>23</sup>

**Figure I-2: Total Credits and Deficits for All Fuels Reported and Cumulative Credit Bank**



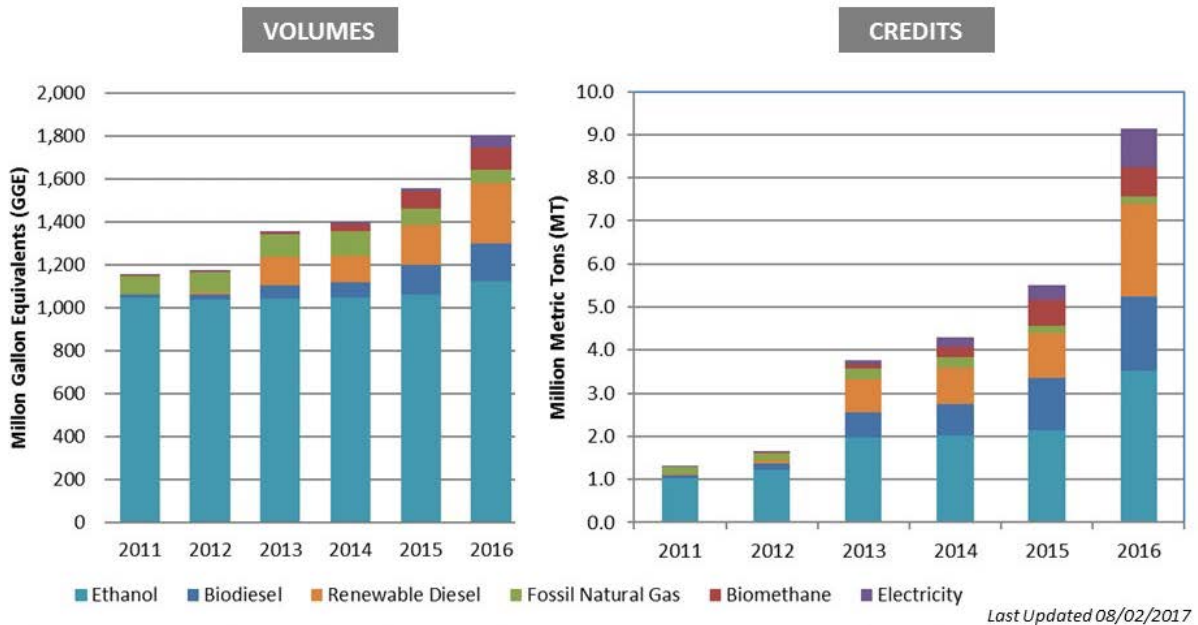
The LCFS is driving rapidly increasing use of low carbon fuels in California. Before the LCFS, the only alternative fuels with market share were natural gas and ethanol. Between 2011 and 2016, renewable diesel use has increased from less than 2 million to

<sup>22</sup> LCFS Data Dashboard. Figure 11 Map of LCFS Beneficiaries Are Dispersed Throughout California. Beneficiaries include California municipal transit agencies, fueling facilities, equipment service providers, utilities, as well as fuel producers and project developers across the U.S. and abroad. Available at: <https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>.

<sup>23</sup> LCFS Data Dashboard. Figure 9 LCFS Credit Market Net Position Histogram. Available at: <https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>.

250 million gallons per year, as shown in Figure I-3. Biodiesel use has grown from 12 million to 163 million gallons. Renewable natural gas use in vehicles has increased from 2 million to 87 million diesel gallons equivalent. Credits in 2016 were generated primarily from ethanol (39 percent), renewable diesel (24 percent), biodiesel (19 percent), and to a lesser—but growing—extent, from biomethane (seven percent) and electricity (nine percent).

**Figure I-3: Annual Growth in Alternative Fuel Volumes and Credit Generation by Fuel Type**



Through ongoing innovation, fuel producers are achieving significant reductions in the carbon intensities of their fuel pathways. New projects with the potential to generate significant credits are being explored at biofuel production facilities, waste management operations (e.g., landfills, livestock manure and wastewater treatment plants), crude production fields (e.g., solar-generated electricity and steam) and petroleum refineries (e.g., production of renewable hydrogen and co-processing of renewable feedstocks). Providers of electricity and hydrogen for battery electric and fuel cell vehicles are also increasing participation in the program.

Credit prices and trading activity reached all-time highs in 2017. Over eight million LCFS credits were sold or traded in approximately 940 transactions in 2017 with a weighted average credit price of \$89/metric ton carbon dioxide equivalent (MTCO<sub>2e</sub>),<sup>24</sup> demonstrating an active credit market with an annual transactional value of over \$700 million. More than 255 active entities are registered for reporting in the LCFS Reporting Tool and Credit Bank & Transfer System (LRT-CBTS), and 459 individual alternative

<sup>24</sup> Weekly LCFS Credit Transfer Activity Report Activity Log. Available at: <https://www.arb.ca.gov/fuels/lcfs/credit/lrtweeklycreditreports.htm>.



fuel pathways have been certified with carbon intensities below the current benchmarks. About 180 biofuel facilities are registered under the LCFS as supplying low carbon fuels to California.

In a June 22, 2017 LCFS Progress Report on the Low Carbon Fuel Standard<sup>25</sup> to the Board, staff compared actual data from 2016 to the illustrative compliance scenarios that were developed in the 2015 rulemaking process, alongside projections developed by Boston Consulting Group (BCG) for the Western States Petroleum Association, and by Chevron. The comparison showed that actual consumption of alternative fuels exceeded all parties' projections, and CARB's forecasted credit generation potential was reasonable in spite of unanticipated increases in gasoline demand.

The current regulation requires staff to conduct a program review and present results to the Board by January 1, 2019.<sup>26</sup> The record created in the 2018 amendments rulemaking, including the information presented in this Staff Report, at Board Hearings, and through responses to public comments in staff's Final Statement of Reasons, fulfills this requirement.

The current LCFS targets a 10 percent reduction in average fuel carbon intensity by 2020 and maintains that target for all subsequent years. A primary objective of this rulemaking is to strengthen the compliance targets of the LCFS regulation through 2030 so that the LCFS continues to serve as a key policy to reduce GHG emissions from the transportation sector. Achieving the GHG reduction goals of SB 32 will require significant changes in all economic sectors. California's transportation industry remains the largest contributing sector to the GHG Inventory,<sup>27</sup> yet many alternative fuels with demonstrated feasibility are available today at scale. The proposed LCFS targets will signal the market to identify the most promising long-term ultra-low carbon fuels solutions and invest in these alternatives to ensure greater reductions beyond the next decade in efforts to avoid the most catastrophic impacts of climate change. Specifically, the proposed regulation will support California's progress toward decarbonization and diversification of the transportation fuel pool.

### **C. Overview of the Proposed Amendments**

This section provides a broad overview of amendments staff is proposing for adoption in 2018. Chapter II provides a more in-depth description of the purpose for the rulemaking and the problems that the proposal is intended to address. Chapter III provides a summary, purpose and rationale for each change to the regulation order. The proposed changes reflect a range of intentions: from simple updates to improve the

---

<sup>25</sup> Board Agenda Item # 17-6-4. Staff presentation available at: <https://www.arb.ca.gov/board/books/2017/062217/17-6-4pres.pdf>

<sup>26</sup> Section 95496(b) of the current regulation. Available at: <https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf>.

<sup>27</sup> California Greenhouse Gas Emission Inventory - 2017 Edition. Available at: <https://www.arb.ca.gov/cc/inventory/data/data.htm>

program’s overall effectiveness, to more significant proposals for improving California’s long-term ability to support the supply of increasingly lower-CI fuels.

The most significant change in this proposal is to both strengthen and smooth the CI reduction benchmarks through 2030 in-line with the California’s 2030 GHG target enacted through SB 32 (Pavley, 2016). These benchmarks provide the basis of calculating credits for low carbon fuels and deficits for high carbon fuels.

If adopted, the proposed amendments would require a 20 percent reduction in fuel CI from a 2010 baseline by 2030, as shown in the proposed CI benchmark schedule listed in Table I-1 and shown in Figure II-1. The proposed amendments will also smooth the schedule by linearly reducing by 1.25 percent annually from a 5 percent reduction in 2018 to the 20 percent value in 2030.

**Table I-1: Proposed LCFS Schedule for Percentage Reduction in CI**

2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
6.25	7.50	8.75	10.00	11.25	12.50	13.75	15.00	16.25	17.50	18.75	20.00

The process for determining the annual carbon intensity benchmarks is detailed in Chapter 8 and Appendix E. Other proposed changes include allowing new fuel types to generate credits and adding an independent third-party verification program for data reported under LCFS, including an accreditation program for verifiers.

Additionally, amendments are proposed to further streamline and clarify existing requirements of the LCFS regulation, to update program tools and data, and to integrate existing processes (such as fuel pathway application, CI determination, and reporting of quarterly and annual fuel transactions) with the proposed third-party verification program.

Table I-2 provides a summary of the proposed changes to the regulation. Staff began conceptually discussing many of these items during an informal public process initiated in March of 2016, hosting 22 workshops and fuel-specific working meetings through December of 2017. The informal public process is detailed in Chapter XI.

**Table I-2: Summary of Proposed Regulatory Amendments to the LCFS Regulation**

Topic	Proposed Regulatory Updates
<b>General</b>	<ul style="list-style-type: none"> <li>• Definition updates and additions, as needed</li> <li>• Improve consistency and clarity in referring to specific entities affected by the regulation and the types of data reports</li> <li>• Ensure accuracy and support better accounting through addition of recordkeeping and reporting requirements</li> <li>• Minor updates for typographical errors, clarifications, and organization of the rule, that do not materially affect requirements</li> </ul>
<b>Compliance, Program Targets &amp; Credit Generation</b>	<ul style="list-style-type: none"> <li>• Strengthen the targets through 2030: revise benchmarks for gasoline, diesel, and jet fuel substitutes from 2019 to 2030</li> <li>• Add new credit generating fuels and vehicle categories to incent further reductions, including alternative jet fuels</li> <li>• Adopt accounting and permanence protocols to enable credit generation for carbon capture and sequestration projects</li> <li>• Establish a Buffer Account to mitigate risk of credit invalidation</li> <li>• Shift credit generation to the end of each quarter and require business partner reconciliation in order to limit the scope of verification</li> </ul>
<b>Entities and Eligibility</b>	<ul style="list-style-type: none"> <li>• Enable trading exchanges to participate in the LCFS market to facilitate investment in new credit-generating projects and alternative fuels production</li> <li>• Enable account holders to designate a representative to manage fuel transactions reporting and credit transfers</li> <li>• Modify eligibility to provide flexibility while further clarifying the responsibilities of program participants</li> </ul>
<b>Fuel Pathways Applications and CI Determination</b>	<ul style="list-style-type: none"> <li>• Integrate third-party validation step into the certification process</li> <li>• Update LCA modeling tools and eliminate need for most producers to have familiarity with the CA-GREET model</li> <li>• Add new Lookup Table pathways, allow for updates to electricity pathways</li> <li>• Expand flexibility to recognize GHG benefits of low-CI electricity coupled with ZEV fueling infrastructure</li> <li>• Add ongoing responsibilities for submittal of Fuel Pathway Reports to ensure CI conformance</li> <li>• Extend the time period over which conformance with a certified CI score is evaluated</li> <li>• Add a process for innovative pathways to be evaluated before operation commencement</li> </ul>

	<ul style="list-style-type: none"> <li>• Reorganize text to improve readability</li> </ul>
<b>Fuel Transactions Reporting and Data Management</b>	<ul style="list-style-type: none"> <li>• Limit period of time that fuel can be transferred with credits/deficits attached</li> <li>• Add Verification Portal to the data management system for verifiers to have access to relevant applicant information</li> <li>• Require Fueling Supply Equipment registration for some fuels to avoid potential double counting of transactions reported at a distributed level</li> <li>• Further clarify requirements for reporting fuel exports</li> </ul>
<b>Petroleum and Project-based Credits</b>	<ul style="list-style-type: none"> <li>• Update Crude Oil Lookup Table</li> <li>• Improve accounting mechanisms for refinery hydrogen and investment credit pilot projects</li> <li>• Expand steam quality ranges for solar steam to improve accuracy of innovative crude crediting provisions</li> </ul>
<b>Verification Program</b>	<ul style="list-style-type: none"> <li>• Change reporting responsibilities for fuel transactions, CI data, and projects to integrate a system for verification by accredited third-parties and the Board’s staff</li> <li>• Identify entities responsible for reporting and recordkeeping to enable verification</li> <li>• Establish requirements for verification process, including: frequency and deadlines for verification; verification body selection and rotation requirements; requirements for site visits, sampling plans, data checks, assessing conformance and material misstatement, and completion of verification services.</li> <li>• Establish accreditation requirements for third parties providing verification services</li> <li>• Require demonstration to CARB of no conflict of interest</li> </ul>

## II. THE PROBLEM THAT THE PROPOSAL IS INTENDED TO ADDRESS

California needs to diversify the state's fuel pool, support demand for increasingly lower-CI fuels, and promote transformative innovation in the transportation sector to achieve our mid- and long-term greenhouse gas (GHG) targets. In this chapter, staff provides a description of the purpose for the rulemaking and the problems the proposed amendments are intended to address. A description, purpose and rationale for each of the proposed updates and revisions are provided in Chapter III.

Staff is proposing amendments to the regulation in order to:

- Strengthen the carbon intensity benchmarks through 2030 in order to help achieve the SB 32 2030 GHG target;
- Expand the fuel types to which the LCFS regulation applies in order to encourage additional actions in areas where reductions will be needed to meet long-term GHG goals;
- Improve accuracy and add flexibility to incent the installation of additional low carbon electricity supply coupled with expansion of ZEV fueling infrastructure;
- Adopt accounting and permanence protocols to enable credit generation for carbon capture and sequestration projects;
- Improve crediting for innovative actions at conventional fuel refineries;
- Further ensure accuracy of the data that underlies the LCFS program and associated market;
- Simplify and streamline application and reporting requirements for regulated entities to encourage greater participation and assist participant compliance;
- Update regulatory values (e.g., EER, energy densities) and LCA modeling tools to use more detailed or recent data;
- Include an independent third-party verification and verifier accreditation program to ensure accuracy of LCFS reported data, and reduce requirements for regulated entities to submit demonstrations and documents to CARB for staff review;
- Address the Court's direction from POET's legal challenge; and
- Make minor updates for typographical errors, clarifications, and organization of the rule that do not materially affect requirements.

## **A. Strengthen the Average Carbon Intensity Requirements Through 2030**

Increasing the stringency of the LCFS carbon intensity targets is necessary to achieve California's 2030 GHG target. Maintaining steady carbon intensity reductions through 2030 will ensure that low-carbon alternatives to petroleum fuel are available in sufficient quantities in the long-term.

Achieving California's mid- and long-term GHG and air quality goals will require a renewable portfolio of transportation fuels—including electricity and hydrogen—in amounts well beyond the current estimated trajectories. The transportation sector remains the largest contributing source of GHG emissions in the state inventory. The LCFS has been an effective measure for increasing the use of low carbon alternatives to fossil fuels in California, by providing significant economic benefits to the credit generating entities who participate in the program, including municipal transit agencies, alternative fueling facilities, equipment service providers, fuel producers and project developers across the U.S. and abroad.

In addition to other state and federal GHG-reduction programs, the proposed amendments are expected to reduce life cycle GHG emissions of transportation fuels consumed in California by about 70 million metric tons (MMT) between 2019 and 2030 as compared to business as usual (see Chapter IV of this Staff Report for additional discussion of the projected GHG benefits). Greater diversification of the State's fuel portfolio will also support California's ongoing efforts to improve ambient air quality. Chapter V of this Staff Report summarizes the air quality and public health benefits of the proposed regulation.

The LCFS plays a role in supporting other state GHG reduction efforts; notably, the Short-Lived Climate Pollutant (SLCP) Strategy, Advanced Clean Cars (ACC), Mobile Source Strategy (MSS), Sustainable Freight Action Plan (SFAP), and Renewable Portfolio Standard (RPS). The SLCP leverages the potential high value of LCFS credits to incentivize methane reductions from dairy and livestock waste management operations. The goals of the ACC are advanced by directing the proceeds from LCFS credit sales earned by electric utilities to offer rebates for EV charging; similarly, the opportunity to generate LCFS credits helps to reduce the upfront costs for fleets to purchase new zero-emission trucks and equipment to achieve the SFAP goals. By recognizing the carbon intensity of renewable electricity used to produce transportation fuels, the LCFS rewards fuel providers across the supply chain for the displacement of fossil fuel consumption by biomethane, wind, solar, and other lower carbon technologies, and offering further reward for renewable power to fuel above and beyond the RPS.<sup>28</sup>

California's 2017 Climate Change Scoping Plan Update sets out the State's path to achieve the SB 32 target. The 2017 Climate Change Scoping Plan Update proposes strengthening the LCFS benchmarks through 2030 as one of the key measures for

---

<sup>28</sup> These amendments increase the flexibility of accounting for the use of such power.

achieving the State's GHG 2030 target.

The LCFS regulation defines a carbon intensity reduction target (or benchmark) for each year, which the current regulation refers to as the "compliance schedule." Achieving the SB 32 GHG target will require the use of a portfolio of low carbon transportation fuels beyond the amount expected to result from the current compliance schedule. Using market data alongside techno-economic models to evaluate a variety of transportation fuel pathways, staff has conducted an in-depth scenario analysis that informed the 2030 target and annual benchmarks for carbon intensity reduction from 2019 through 2030. This analysis helps explore possible compliance outcomes and facilitates improved understanding of LCFS economics and compliance feasibility.

Staff has developed several modeling tools that take into account feedstock supply, fuel prices, fuel incentives, and capacity constraints to assess the technical and economic feasibility of bringing low carbon fuels to California. Staff used these modeling tools, together with stakeholder feedback and information obtained from market reports on alternative fuel technology development, to assess fuel supply variability and sensitivity to LCFS credit prices and other uncertain market effects on a year-by-year basis. Model results provide staff with a better understanding of key variables and assumptions that ultimately affect compliance. While a 20 percent target may be conservative under some possible techno-economic assumptions, there are many market-based variables, such as growth in transportation fuel demand, which may make more aggressive compliance targets difficult to meet. Across most modeled scenarios, a 20 percent target is feasible with sufficient electrification (including hydrogen vehicles), increased use of commercially available low-CI fuels like renewable diesel, biodiesel, ethanol, and biomethane, and some reduction in the carbon intensity of the conventional fuel supply chain through project-based credits.

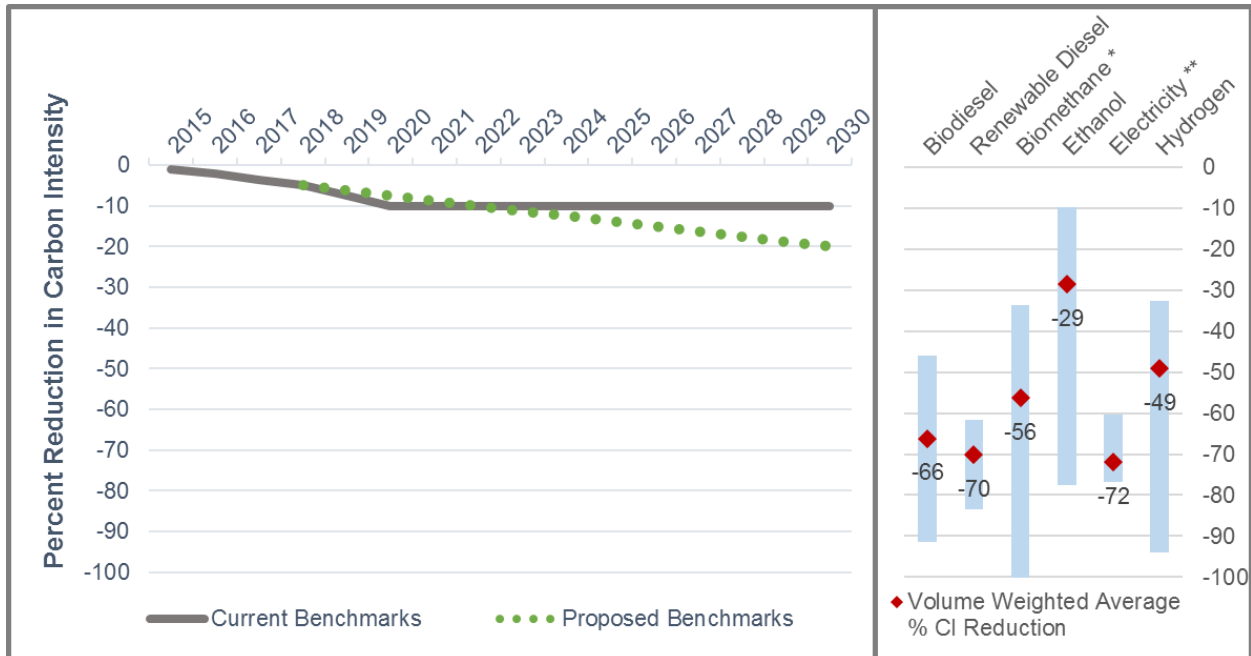
Based on comments received, staff evaluated a wide range of CI benchmark trajectories. Some scenarios indicated that a reduction greater than the 18 percent by 2030 included in the 2017 Climate Change Scoping Plan Update was achievable. Ultimately, staff determined a more stringent CI target of 20 percent is both achievable and necessary to promote the low carbon fuel technology advancement expected of the LCFS in the SB 32 framework.

Also, based on stakeholder feedback and additional analysis, staff recognized that the near-term benchmarks in the current regulation could, in some scenarios, lead to a draw-down of the credit bank in the next few years. In some scenarios, this leads to an unnecessary short-run jump in credit prices. Therefore, staff determined that adjusting the benchmarks for years 2019 through 2021 would be appropriate.

Figure II-1 shows staff's proposed benchmarks as compared to the benchmarks in the current regulation for years 2015 through 2030. When considering the full period from 2019-2030, staff's proposal achieves 70 MMT more cumulative reductions relative to current regulation. The right-hand side of Figure II-1 shows the range and volume-weighted average percentage reduction in carbon intensity that was achieved in the first

three quarters of 2017, per alternative fuel type as a point of comparison. These values supply a useful comparison as we begin to plan for a decarbonized economy.

**Figure II-1: Current and Proposed Annual Carbon Intensity Benchmarks as Compared to CI Reductions Achieved in 2017 by the Most Common Alternative Fuels**



\* Negative CIs have been achieved for some fuel pathways but are not shown.

\*\* The average percent CI reduction for electricity shown represents Light-Duty Electric Vehicle charging.

Chapter 8 and Appendix E of this Staff Report provide additional details on the data sources and methodology that staff has relied on to evaluate feasible LCFS compliance scenarios.

## B. New Fuels Subject to the Regulation

Staff is proposing amendments that would broaden the list of fuels subject to the LCFS regulation and alter the opt-in and/or exempt status of particular fuels. The objective is to encourage additional GHG reductions in specific areas where decarbonization will be important to meet California’s long-term climate goals. The proposed changes include:

- The addition of alternative jet fuels (AJF) as opt-in credit-generating fuels;
- Requiring fossil compressed natural gas (CNG) to be covered under the program;
- Requiring hydrogen to be covered under the program;
- Removing the exemption for propane and, instead, requiring this fuel to be covered under the program; and
- Allowing alternative fuels used in military tactical vehicles and aircraft to opt-in to receive credit in the program.



## Alternative Jet Fuel

AJFs are “drop-in” fuels made from fossil or renewable sources, which can replace conventional jet fuels without the need to modify aircraft engines and existing fuel distribution infrastructure. When used at approved blending levels, staff expects AJFs to have the same performance characteristics as conventional jet fuel.

Staff’s proposal includes amendments to allow AJF to generate credits as an opt-in fuel under the LCFS. Under this proposal, conventional jet fuel, in contrast to gasoline and diesel, would not be subject to the LCFS regulation and would therefore not generate deficits. Similar to other liquid alternative fuels under the LCFS, the amended rule would designate the AJF producer or importer as the first fuel reporting entity eligible to generate credits. Opt-in AJF pathways would be eligible to generate credits for the total volume loaded to planes in California, whether the destinations are in California or out of the state.

The proposed amendments include an annual compliance schedule determined specifically for calculating credit from alternative jet fuels. The AJF annual benchmarks are anchored to the 2010 baseline CI for conventional jet fuel and incorporate the same annual percent reductions as the benchmarks for gasoline and diesel. The CI of AJF pathways, as well as the 2010 baseline CI for conventional jet fuel, were determined using the CA-GREET3.0 model. AJF would generate credits based on the difference between the AJF pathway’s CI and that of the jet fuel benchmark for the given year.

Including AJF in the LCFS would result in several benefits. First, greater use of AJFs would lead to a reduction in global GHG emissions. LCFS crediting of AJFs would signal California’s interest in addressing a significant and growing source of GHG emissions—the aviation sector. GHG emissions from aviation contribute to approximately two percent of current total global emissions and are expected to grow.<sup>29</sup>

Second, because AJF and renewable diesel (RD) are often produced in the same facility using the same feedstock, inclusion of AJF may lead to increased investment in such facilities, thereby increasing the production of both alternative fuels. The airline industry is developing a strong record for partnering with alternative fuel producers through direct investment and off-take agreements,<sup>30</sup> which assist in providing the certainty necessary to get these advanced biofuel facilities built.

Third, providing incentive for use of AJFs may reduce criteria pollutant emissions during taxi, takeoffs, and landings, which could improve air quality and thereby reduce health impacts, especially near airports. Recent studies have shown that there are significant

---

<sup>29</sup> <https://www.icao.int/environmental-protection/Pages/aircraft-engine-emissions.aspx>.

<sup>30</sup> Hileman, Jim. ICAO Seminar on Alternative Fuels 2017. February 8-9, 2017. Presentation on Alternative Jet Fuels: Factors that have Enabled Success. Slides 3-5.

reductions in particulate matter and sulfur oxide emissions and a slight reduction or no change in nitrogen oxides (NOx) emissions when AJFs replace conventional jet fuel.<sup>31</sup>

### Fossil CNG

In the current regulation, North American fossil CNG is an opt-in fuel because this fuel is presumed to have a CI that meets the standard in every year through 2020. As the CI standard continues to decline beyond 2020, however, staff anticipates that the average CI of fossil CNG will exceed the standard and become a deficit generating fuel.

Therefore, staff proposes to remove the opt-in status of fossil CNG, thereby requiring all quantities of fossil CNG dispensed to vehicles in California to be reported under the LCFS. Liquefied natural gas (LNG), and L-CNG (LNG that is regasified and compressed for dispensing to CNG vehicles) are already required to report under the LCFS; the result is a requirement that all transportation fuel derived from fossil natural gas would be covered by the program.

Renewable natural gas pathways, which staff anticipates will continue to have CIs below the declining standards, would maintain their opt-in status. Given the rapid rate at which renewable natural gas has replaced fossil natural gas in CNG vehicles, staff expects that CNG providers will be able to comply with these requirements.

### Hydrogen

Similar to North American CNG, hydrogen is an opt-in fuel under the current regulation because this fuel is presumed to have a CI that meets the compliance standard in every year through 2020. Although it is possible to produce hydrogen in a high-CI way, hydrogen is not expected to become a deficit generating fuel given the efficiency of fuel cell vehicles and the focus of the industry on CI performance. However, staff is proposing changing the opt-in status of hydrogen to allow CARB to use the LCFS reporting framework to monitor statewide compliance with the greenhouse gas emission and renewable energy resource requirements of California SB 1505.<sup>32</sup> The low volume threshold exemption that exists in the current regulation (an aggregated 420 million megajoules (MJ) of fuel per year by all providers of a particular fuel, equivalent to 3,500 metric tons per year of hydrogen) remains in place under this proposal, thereby requiring the reporting of all hydrogen dispensed for transportation purposes only after statewide use grows to reach this threshold.

The proposed amendments also clarify who is eligible to generate credits in the situation where an upstream party, such as an industrial gas producer, supplies hydrogen to a refueling station, where it is compressed and cooled prior to being dispensed. The fueling facility owner is designated as the first fuel reporting entity

---

<sup>31</sup> Corporan, Edwin. December 2010. Alternative Fuels Test on a C-17 Aircraft: Emissions Characteristics. <http://www.dtic.mil/dtic/tr/fulltext/u2/a536842.pdf>

<sup>32</sup> California Senate Bill 1505, Lowenthal, 2006. Available at: <https://www.arb.ca.gov/msprog/hydprod/hydprod.htm>

eligible to generate the credits. This entity would have the ability to contractually pass the reporting responsibilities (with the attendant opportunity to generate credits) to the upstream producer or a designee.

## Propane

Liquefied petroleum gas (LPG or “propane”), including renewable propane, is exempt from the current regulation, meaning its use as a transportation fuel generates neither credits nor deficits. Staff is considering removing this exemption for propane, which would require the reporting of fossil propane used in transportation, and allow renewable propane to opt-in to report and generate credits under the LCFS.

As of 2015, more than 32 million gasoline gallon equivalent (GGE) of propane were used in California as a transportation fuel, almost tripling over the past 15 years.<sup>33</sup> Propane on-road use is expected to grow continuously through 2030.

Tailpipe emissions from most propane vehicles are expected to be comparable to those of gasoline and diesel vehicles with modern emission controls.<sup>34,35</sup> However, the development of low NOx propane engines may provide additional NOx emission reduction benefits as compared to gasoline engines.<sup>36</sup> Propane vehicles are an economical option for a broad variety of markets, including school buses, municipal buses, shuttle vans, forklifts, delivery trucks, taxis, and pickups.

The CI performance of fossil propane varies depending on how it is produced, but generally fossil propane is expected to provide only a small CI benefit relative to displacing fossil gasoline or diesel. Renewable propane offers greater opportunities for CI reduction. Renewable propane can be produced using a number of production pathways and from a number of low-CI feedstocks. Removal of the propane exemption is expected to result in displacement of fossil-based propane currently used for transportation in California by lower CI renewable sources. Renewable propane is co-produced in the renewable diesel and jet production process from hydrotreating of renewable oils. Renewable propane can also be produced from catalytic dehydration of glycerol, a by-product of biodiesel production process. Currently, nearly 41 million gallons of biodiesel are produced annually in California, so significant quantities of bio-

---

<sup>33</sup> California Transportation Data for Alternative Fuels and Vehicles. U.S DOE Alternative Fuels Data Center. <https://www.afdc.energy.gov/states/ca>.

<sup>34</sup> Alternative Fuel Guidelines for Alternative Transportation Systems. John A. Volpe National Transportation Systems Center. January 2011

<sup>35</sup> Propane Vehicle Emissions. U.S DOE Alternative Fuels Data Center. [https://www.afdc.energy.gov/vehicles/propane\\_emissions.html](https://www.afdc.energy.gov/vehicles/propane_emissions.html).

<sup>36</sup> Public Workshop on Fiscal Year 2017-18 Funding Plan for Clean Transportation Incentives 2017 Available at: [https://www.arb.ca.gov/msprog/aqip/fundplan/1718\\_draft\\_funding\\_plan\\_workshop\\_100417.pdf?\\_ga=2.94821848.539688609.1508425887-114512377.1497044099](https://www.arb.ca.gov/msprog/aqip/fundplan/1718_draft_funding_plan_workshop_100417.pdf?_ga=2.94821848.539688609.1508425887-114512377.1497044099).

glycerol should be available and at low cost. Pyrolysis oils, hydrotreated pyrolysis oil, and vegetable oils can be co-processed with vacuum gas oil (VGO) in fluid catalytic crackers (FCC) at refinery to produce gasoline and light cycle oil. Light gases from the FCC could contain significant propane (up to 18 percent by weight) as a by-product.<sup>37</sup>

Similar to fossil CNG, staff anticipates that the average fossil propane pathway may generate deficits as the CI standard declines beyond 2020, as proposed in this rulemaking. Therefore, reporting of dispensed volumes for fossil propane would be required. A Lookup Table CI value for fossil propane is provided in the proposed regulation for convenience of station owners, who would be designated as the first fuel reporting entity. Renewable propane pathways; however, will likely have a CI value that meets the compliance standard for each year, and under staff's proposal it is classified as an opt-in fuel.

### Military Vehicle Applications

The LCFS currently exempts all fuels supplied for use in military tactical vehicles and support equipment from both credit and deficit generation. Producers of renewable fuels used in these applications have expressed concern that this provision reduces their incentives to sell low carbon fuels to the military. These producers have requested opt-in status for the alternative fuels sold for use in these military applications. Staff is supportive of this approach because it simplifies the decision-making framework created by the LCFS for low carbon fuel producers.

Staff proposes to remove the current provision exempting military vehicle applications (vehicles and tactical equipment as defined in title 13, CCR section 1905(a) and CCR, title 17, section 93116.2(a)(38)), and to add an exemption specifically for conventional fuels used in these applications. This will allow alternative fuels to earn credit for use in these applications, while continuing to exempt conventional fuels used in these applications from generating deficits.

### Other New Applications

Staff proposes changes that would enable several other new applications, such as electric transport refrigeration units and electric motorbikes, to earn credits, as well as expanding the flexibility to allow low-CI electricity to be attributed to serve electric vehicle and hydrogen electrolyzer loads. Many of these applications are proposed to support measures investigated in the California Sustainable Freight Action Plan.<sup>38</sup> These specific changes are discussed further in Chapter III.

---

<sup>37</sup> Wang, C.; Li, M.; Fang, Y. Coprocessing of Catalytic-Pyrolysis-Derived Bio-Oil with VGO in a Pilot-Scale FCC Riser. *Industrial & Engineering Chemistry Research* 2016 55 (12), 3525-3534 DOI: 10.1021/acs.iecr.5b03008

<sup>38</sup> State of California. California Sustainable Freight Action Plan. July 2016. Available at: [http://dot.ca.gov/hq/tpp/offices/ogm/cs\\_freight\\_action\\_plan/Documents/CSFAP\\_FINAL\\_07272016.pdf](http://dot.ca.gov/hq/tpp/offices/ogm/cs_freight_action_plan/Documents/CSFAP_FINAL_07272016.pdf)

### C. Addition of Third-party Verification

The third primary objective of the proposed amendments is to add an independent third-party verification program to support the accuracy of data reported to the LCFS. A key element of a credible reporting program is independent verification of the reported data to ensure completeness and accuracy, and conformance with the regulation. To date, the LCFS has relied upon a robust reporting program that includes staff evaluation of fuel CI during the fuel pathway application process and audits of the reporting of quarterly fuel quantities. Under the proposed regulation, verification would be performed by qualified and trained third-party verifiers that meet specifications for education and experience, and demonstrate that there is no conflict of interest for verifying the reported data due to current or previous relationships with the facility operator. Verifiers would be required to attend a multi-day CARB approved verifier training course and successfully complete an exit exam prior to being accredited to provide verification services for the LCFS program.

The proposed verification program would increase confidence in LCFS program data and streamline the use of staff resources. The basic mechanics of the program—credit and deficit generation—rely on a considerable amount of information to be supplied to CARB and reviewed by its staff. The determination of carbon intensity for a given fuel pathway, or emission reductions achieved by a project, dictates the number of credits or deficits generated per unit of fuel. The quantities of alternative fuel that are reported as fuel transactions result in credit or deficit generation. Thus, CARB and program participants must be able to rely on the accuracy of the underlying information. CARB has extensive experience with an analogous system under the regulation for the Mandatory Reporting of Greenhouse Gas Emissions (MRR) pursuant to AB 32, and through the verification of GHG compliance offset projects under CARB’s Cap-and-Trade Regulation.<sup>39,40</sup>

Elements of verification proposed in the regulation include (1) annual site visits to ensure that all required sources and processes are included in the emissions estimates and that the data report is complete, (2) development of a plan for specific verification activities, including site visits and document reviews, (3) development of a sampling plan to conduct data checks on the reported data, that considers source contributions with the highest emissions and greatest uncertainty, and (4) a verification opinion submitted to CARB and the reporting entity. In addition, staff is proposing triennial verification for alternative liquid fuel production facilities that generate no more than 6,000 credits, due to the low risk to the LCFS credit market and to reduce the costs associated with verification for smaller projects.

---

<sup>39</sup> AB 32 explicitly supported verification calling for CARB to “adopt regulations to require the reporting and verification of statewide greenhouse gas emissions and to monitor and enforce compliance...” Health and Safety Code (H&SC) section 38530(a). Program information on MRR verification is available at: <https://www.arb.ca.gov/cc/reporting/ghg-ver/ghg-ver.htm>.

<sup>40</sup> Offset Verification Program. Available at: <https://www.arb.ca.gov/cc/capandtrade/offsets/verification/verification.htm>.

In October of 2016, CARB released a white paper presenting initial thoughts on a framework for Low Carbon Fuel Standard Verification.<sup>41</sup> Staff's proposal builds off many of the concepts explained in that document and subsequent stakeholder feedback.

#### **D. Other Proposed Amendments**

Additional proposed changes are summarized in Table I-2, and detailed in Chapter III. Many of these amendments serve to support the primary objectives of the rulemaking, namely: strengthening the 2030 target and annual benchmarks for carbon intensity reduction from 2019 through 2030, adding fuels that participate in the program, and requiring third-party verification. For example, expanded flexibility to recognize use of low-CI electricity for EV charging and hydrogen production would promote decarbonization of these fuels and make these vehicles truly "zero emission" on a life cycle basis; modification of the fuel pathway application process would accommodate the process of obtaining verification services; the proposed revision to entity names would further clarify responsibilities of various parties who are subject to the regulation, a change that is necessary in conjunction with the third-party verification system; the development of new benchmarks for jet fuel would support the calculation of credits for AJF; and the addition of Lookup Table pathways for fossil CNG and LPG would facilitate the obligation of these fuels to be reported in the program.

Other amendments have been proposed that do not directly support those three changes, but do support the regulation's underlying purposes. For example, the verification system is not the sole means by which staff seeks to improve accuracy and data quality; the requirement for Fueling Supply Equipment registration serves this end by enabling staff to monitor risk of double counting by two entities for the same quantity of fuel. The update of modeling tools, conversion factors, and standard values also improves accuracy in the quantification of GHG reductions. The proposed adoption of an accounting and permanence protocol for carbon capture and sequestration allows such projects to generate credits. Some changes encourage modest reductions in areas that may later become critical to meet long-term climate stabilization goals.

Finally, a number of amendments are proposed to achieve secondary objectives, such as simplifying and streamlining application and reporting requirements in order to encourage greater participation and improve administrative efficiency. An example is the proposed option for some fuel providers to authorize a designee to report on their behalf. Staff expects that this provision will support the participation of smaller fueling facility operators, transit agencies, and EV charging services providers, allowing them to benefit from the program more efficiently with less administrative effort. The use of new Simplified CI Calculators for Tier 1 fuel pathway applications will reduce application preparation time by the applicant; reduce evaluation and processing time by the Board staff; and enhance transparency by establishing a standard set of raw data inputs,

---

<sup>41</sup> Available at: [https://www.arb.ca.gov/fuels/lcfs/lcfs\\_meetings/verification\\_whitepaper\\_102116.pdf](https://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/verification_whitepaper_102116.pdf)

whose accuracy is ensured through independent third-party verification. When staff has been made aware of a federal or other program with a similar reporting or verification requirement, harmonization was sought to minimize duplicative efforts. Staff has revised the regulation extensively order to improve the organization, in hopes that this will aid stakeholders and those subject to the regulation in clearly interpreting their obligations. Many changes, particularly in new sections 94588.1 to 95488.10, do not materially affect requirements, but rather are intended to improve organization and readability.

### III. THE SPECIFIC PURPOSE OF EACH ADOPTION, AMENDMENT, OR REPEAL & THE RATIONALE FOR CARB'S DETERMINATION THAT EACH IS REASONABLY NECESSARY

#### Subarticle 7. Minor changes throughout the Low Carbon Fuel Standard Regulation

##### Description of Problem

Minor changes, which do not have a material impact on requirements of the regulation, are proposed throughout subarticle 7 to improve consistency and clarity.

##### Proposed Solution

- The terms “volume” and “amount” are replaced with “quantity.”
- The term “shall” is replaced with “must.”
- The term “regulated party” is replaced with a more distinct specific entity name. The term “regulated party” has been replaced with “fuel reporting entity,” or “regulated entity,” as applicable to be consistent with the proposed definitions, related to LCFS participants. See also the problem, solution and rationale for section 95481(a) Definitions pertaining to *Classification of LCFS Participants*.
- The term “average carbon intensity requirements” is replaced with “annual carbon intensity benchmarks.” See also the problem, solution and rationale for section 95484(a) through (g).
- The term “approved” is replaced with “certified,” when used in the context of a fuel pathway that has been evaluated and approved for credit or deficit generation per the process described in sections 95488 to 95488.10.

##### Rationale Supporting Proposed Solution

These changes maintain consistency and clarity in the regulation. These terminologies are used throughout the regulation and the reasoning provided here is applicable for all sections where these terms appear.

- “Quantity” is more accurate and applicable because many non-liquid fuels are not typically measured, metered or dispensed in volumetric units.
- “Must” is preferred in place of “shall” to reduce the likelihood of misinterpretation.
- For changes related to entity titles and roles, please see the rationale for section 95481(a) Definitions pertaining to Classification of LCFS Participants.
- “Benchmarks” adds clarity without changing the meaning, requirements, or mechanics of the credit and deficit calculations.



- “Certified” is consistent with the use of the term throughout the regulation to mean a fuel pathway that is valid for reporting and generation of credits or deficits.

## **SECTION 95481. DEFINITIONS AND ACRONYMS.**

### **Section 95481(a). Minor changes throughout the Definitions subsection**

#### Description of Problem

Minor changes, which do not have a material impact on requirements of the regulation, are proposed throughout the definitions in section 95481 to improve consistency and clarity.

#### Proposed Solution

Throughout section 95481, the defined terms were capitalized for consistency and references contained within definitions are updated. Numbering of definitions in the current regulation has been updated as new definitions are proposed to be added and current definitions are proposed to be removed.

All new definitions, and proposed changes to definitions in the current regulation that have material impact on requirements, are detailed in this chapter.

#### Rationale Supporting Proposed Solution

These changes maintain consistency and clarity in the regulation.

### **Section 95481(a). Definition for “Above the Rack” (removed)**

#### Description of Problem

The definition of “Above the Rack” in the current regulation is limited to diesel fuel and does not cover CARBOB, although the term is equally applicable to both fuels in practice.

#### Proposed Solution

Staff proposes to remove the definition of “Above the Rack” and add a definition for “Rack.”

#### Rationale Supporting Proposed Solution

Staff is proposing clarifying the responsibility for reporting fuel export in the LRT-CBTS in different scenarios. Staff has classified different scenarios with reference to the rack and thus it is important to have a comprehensive definition for the rack with respect to both diesel fuel and CARBOB.

### **Section 95841(a). Definition for “Adverse Validation Statement” and “Adverse Verification Statement”**

*(see Definitions pertaining to Verification Service Requirements)*

### **Section 95481(a). Definition for “Alternative Fuel”**

#### Description of Problem

The list of fuels in section 95482(a) did not include new fuels that are proposed additions to the LCFS program, and included an unnecessary category of hydrogen blends.

#### Proposed Solution

The section has been revised to include the complete list of alternative fuels that the LCFS regulation applies to, per section 95482(a)(3) to (13), including alternative jet fuel and propane.

#### Rationale Supporting Proposed Solution

The expanded list of fuels allows for more avenues for generating and obtaining credits.

### **Section 95481(a). Definition for “Alternative Jet Fuel”**

#### Description of Problem

New fuels added to the LCFS have not been defined.

#### Proposed Solution

Define “Alternative Jet Fuel.”

#### Rationale Supporting Proposed Solution

Defining alternative jet fuel will allow fuel-reporting entities to know what can generate credits as an alternative jet fuel under the LCFS.

### **Section 95481(a). Definition for “Animal Fat”**

*(see Definitions pertaining to Feedstock Characterization)*

### **Section 95481(a). Definition for “Aviation Gasoline”**

#### Description of Problem

Since staff is proposing to allow alternative jet fuel to generate credits under the LCFS, but continue to exempt conventional jet fuel and aviation gasoline, a definition for aviation gasoline is needed.

#### Proposed Solution

Define “Aviation Gasoline.” Staff is proposing to use the U.S. EPA’s definition of Aviation Gasoline.<sup>42</sup>

#### Rationale Supporting Proposed Solution

Defining aviation gasoline will allow fuel reporting entities to know which aviation fuels are exempt from the LCFS regulation.

---

<sup>42</sup> U.S. EPA <https://www3.epa.gov/ghgreporting/help/tool2014/definitions/aviation-gasoline.html>.

**Section 95481(a). Definition for “Bio-CNG,” “Bio-LNG,” “Bio-L-CNG,” and “Biomethane”**

Description of Problem

The definitions in the current regulation omit biomethane from non-biogas sources, such as gasification of biomass to produce syngas and subsequent methylation to obtain methane of biological origin.

The current definition for biomethane utilizes a technical description of the purification process that is not particularly relevant to the regulation’s requirements, and does not reflect the LCFS practice of accounting for the environmental attributes associated with biomethane.

Proposed Solution

The proposed definition adds synthetic natural gas derived from renewable resources to the description of biomethane sources, and shifts from a technical description of the production process and characteristics of this fuel, to a simpler description that it must “meet pipeline quality natural gas standards.” The proposed change introduces the concept of environmental attributes, which is needed for the book-and-claim accounting. The terms “biomethane” and “renewable natural gas” are interchangeable for the purposes of this subarticle.

The modifier “biogas-derived” is removed from the definition of fuels made from biomethane to align with the proposed change to biomethane.

Rationale Supporting Proposed Solution

As pathways utilizing gasification come into commercial production and in cases where the resulting fuel meets the federal and local standards for pipeline quality, it should be subject to the same treatment and requirements under the LCFS as biomethane derived from biogas.

Because CARB is not the regulatory authority that oversees the chemical, safety, quality, or performance characteristics of fuel, the proposed LCFS regulation defers to existing pipeline standards defined by statute or other regulations.

The term biomethane is interchangeable with renewable natural gas for the purposes of this subarticle, as staff is not aware of any need to distinguish them.

**Section 95481(a). Definition for “Biomass-based Diesel”**

Description of Problem

The definition in the current regulation reads like an entire volume of co-processed fuel would be considered biomass-based diesel, even if the renewable feedstock that was co-processed was only a very small fraction of the overall input.

### Proposed Solution

Staff is proposing to modify the definition.

### Rationale Supporting Proposed Solution

The proposed definition ensures that biomass-based diesel should only include co-processed fuel to the extent that the co-processed renewable diesel is greater than 5 percent of the total diesel volume.

## **Section 95481(a). Definition for “Blendstock”**

### Description of Problem

The current definition of Blendstock refers to the CA-GREET2.0 model, whereas staff is proposing to use the CA-GREET3.0 model. See Description of Problem for 95488.3(b).

### Proposed Solution

Staff proposes to update references to the CA-GREET2.0 model with the CA-GREET3.0 model. See Proposed Solution for 95488.3(b).

### Rationale Supporting Proposed Solution

See Rationale Supporting Proposed Solution for 95488.3(b).

## **Section 95481(a). Definition for “Broker”**

*(see Definition of LCFS Credit Broker)*

## **Section 95481(a). Definition for “Brown Grease”**

*(see Definitions Pertaining to Feedstock Classification)*

## **Section 95481(a). Definitions Pertaining to *Classification of LCFS Participants***

**“Credit Generator,” “Deficit Generator,” “First Fuel Reporting Entity,” “Fuel Pathway Applicant,” “Fuel Pathway Holder,” “Fuel Reporting Entity,” “Joint Applicant,” “Opt-In Fuel Reporting Entity,” “Project Operator,” “Regulated Entity,” “Regulated Party,” “Reporting Party.”**

### Description of Problem

The current regulation defines roles of LCFS participants and establishes their responsibilities. However, with the addition of the third-party verification system, the roles and responsibilities of some participants would change. New or changed responsibilities under the regulation need to be clarified.

### Proposed Solution

Staff is proposing to update the terminology used to define different participants in the program. Staff proposes that any entity subject to the LCFS program is classified as a regulated entity and their individual roles be defined based on their participation.

Staff is proposing to add the following definitions: Deficit Generator, First Fuel Reporting Entity, Fuel Pathway Applicant, Fuel Pathway Holder, Fuel Reporting Entity, Joint Applicant, Opt-in Fuel Reporting Entity, and Project Operator.

Staff is proposing to update following definition: Credit Generator.

Staff is proposing to remove the following definitions: Regulated Party, and Reporting Party. In their place, more specific entity names listed above are used, as appropriate.

#### Rationale Supporting Proposed Solution

Defining the various participants in the program clarifies responsibilities for each participant in the program. The defined terms are used throughout the regulation and the reasoning provided here is applicable for all sections where the terms appear.

### **Section 95481(a). Definition for “Conflict of Interest”**

#### Description of Problem

The addition of a system for third-party verification would use several new terms, including “Conflict of Interest.” What constitutes a conflict is not obvious without further clarification.

#### Proposed Solution

Define “Conflict of Interest.”

#### Rationale Supporting Proposed Solution

Because verifier impartiality is required, the prohibited “Conflicts of Interest” must be given a clear meaning.

### **Section 95481(a). Definition for “Contract Description Code”**

#### Description of Problem

Staff is proposing amendments to allow clearing service providers to participate in the program and provide clearing services to the regulated entities. These amendments include requirements for the clearing service providers to report a contract description code. That term has not been defined elsewhere.

#### Proposed Solution

Staff is proposing to define “Contract Description Code”.

#### Rationale Supporting Proposed Solution

The change will help establish clear reporting requirements for the clearing service providers.

### **Section 95481(a). Definition for “Conventional Jet Fuel”**

#### Description of Problem

Because staff is proposing to allow alternative jet fuel to generate credits under the LCFS, but continue to exempt conventional jet fuel and aviation gasoline from the regulation, staff needs to define what is considered conventional jet fuel.

#### Proposed Solution

Define “Conventional Jet Fuel.” Staff is proposing to define conventional jet fuel as aviation turbine fuel that complies with ASTM Specification D1655-17 (2017)<sup>43</sup>, Standard Specification for Aviation Turbine Fuels. Jet fuel includes Commercial and Military Jet Fuel. Commercial Jet Fuel includes products known as Jet A, Jet A-1, and Jet B. Military Jet Fuel includes products known as JP-5 and JP-8.

#### Rationale Supporting Proposed Solution

Defining conventional jet fuel will allow fuel reporting entities to know which aviation fuels are exempt from the LCFS regulation.

### **Section 95481(a). Definition for “Correctable Errors”**

#### Description of Problem

The addition of a system for third-party verification would use new terms that are defined to convey regulatory meaning. The regulation requires correction of certain errors, and requires a verifier to determine whether errors are correctable, the term “correctable errors” must be defined.

#### Proposed Solution

Define “Correctable Errors.”

#### Rationale Supporting Proposed Solution

Defining “correctable errors” is intended to clarify language used in relation to the consequences of errors that affect reported data, versus misreporting that does not affect reported data. This is also intended to clarify circumstances in which small differences identified between the verifiers’ and reporters’ calculations do not result in a correctable error. This term is necessary based on experience gained during implementation of MRR.

### **Section 95481(a). Definition for “Credit Facilitator”**

#### Description of Problem

The defined term “Credit Facilitator” is no longer used in the proposed regulation text.

---

<sup>43</sup> ASTM Specification D1655-17 (2017), Standard Specification for Aviation Turbine Fuels, August 1, 2017

### Proposed Solution

Staff is proposing to remove the definition of Credit Facilitator as it is no longer applicable based on proposed changes in section 95483.2.

### Rationale Supporting Proposed Solution

The current regulation does not use the term “Credit Facilitator.” Other roles are defined and explained in the LRT-CBTS User Guide available on LCFS web site.<sup>44</sup>

#### **Section 95481(a). Definition for “Credit Generator”**

*(see Definitions pertaining to Classification of LCFS Participants)*

#### **Section 95481(a). Definition for “Deficit Generator”**

*(see Definitions pertaining to Classification of LCFS Participants)*

#### **Section 95481(a). Definition for “Distiller’s Corn Oil”**

*(see Definitions pertaining to Feedstock Classification)*

#### **Section 95481(a). Definition for “Diesel Fuel Blend”**

### Description of Problem

The current definition does not explicitly apply to any 5 percent blend of biomass-based diesel, including 5 percent renewable diesel blended with 95 percent CARB diesel.

### Proposed Solution

Staff is proposing to modify the definition.

### Rationale Supporting Proposed Solution

This change will ensure that the definition also applies to a blend no more than 5 percent biodiesel and no more than 5 percent renewable diesel. The definition will also be consistent with the FTC biomass-based diesel labeling requirements.

#### **Section 95481(a). Definition for “Energy Economy Ratio (EER)”**

### Description of Problem

The definition of “Energy Economy Ratio (EER)” in the current regulation does not state that the reference fuel be used in the same powertrain.

### Proposed Solution

Add to the current definition that EER represent the efficiency of a fuel as used in a powertrain as compared to a reference fuel used in the same powertrain.

### Rationale Supporting Proposed Solution

This change will add more clarity to the current definition of EER.

---

<sup>44</sup> Low Carbon Fuel Standard User Guide Version 1.0 LCFS Reporting Tool (LRT) Credit Bank and Transfer System). CARB, April 26, 2016. Available at:

[https://www.arb.ca.gov/fuels/lcfs/reportingtool/UserGuide-LRT\\_CBTS\\_v1.0\\_04262016.pdf](https://www.arb.ca.gov/fuels/lcfs/reportingtool/UserGuide-LRT_CBTS_v1.0_04262016.pdf)

### **Section 95481(a). Definition for “Environmental Attribute”**

#### Description of Problem

The current regulation does not have a definition for environmental attributes, which encompass renewable attributes of biomethane and represent greenhouse gas emissions reduction recognition in any form.

#### Proposed Solution

Define “Environmental Attribute”.

#### Rationale Supporting Proposed Solution

The concept of “environmental attribute” is needed for book and claim accounting to track biomethane for LCFS reporting purposes as biomethane is not physically delivered to California compared to other LCFS fuels.

### **Section 95481(a). Definition for “Executive Officer”**

#### Description of Problem

The definition in of “Executive Officer” in the Cap and Trade regulation is slightly different.

#### Proposed Solution

Staff is proposing to define “Executive Officer” to match the definition found in the Cap and Trade regulation.

#### Rationale Supporting Proposed Solution

This change will help ensure that the definition of “Executive Officer” in the two regulations are in line.

### **Section 95481(a). Definition for “Exchange”**

#### Description of Problem

Staff is proposing amendments to allow clearing service providers to participate in the program and provide clearing services to the regulated entities. These amendments include requirements for the clearing service providers to report the information about exchange through which the clearing of credits occurred. That term has not been defined elsewhere.

#### Proposed Solution

Staff is proposing to define “Exchange”.

#### Rationale Supporting Proposed Solution

The change will help establish clear reporting requirements for the credits transactions facilitated by clearing service providers through an exchange.



## **Section 95481(a). Definition for “Export”**

### Description of Problem

The LCFS regulation requires that if fuel reported in the LRT-CBTS is subsequently exported out of California then that export must be reported in the LRT-CBTS as export. The term “export” is not currently defined.

### Proposed Solution

Staff is proposing to provide a definition of “Export” to clearly establish what constitutes an export.

### Rationale Supporting Proposed Solution

Providing a definition of export will help entities to clearly establish and identify export transactions. Identifying such transactions is imperative to having complete and accurate reporting of the exports in the program. It will help avoid any misreporting, double reporting, or incomplete reporting of exports.

## **Section 95481(a). Definition for “Feedstock First Collection Point”**

### Description of Problem

“Feedstock First Collection Point” is a proposed new term clarifying a recordkeeping requirement, and requires a definition.

### Proposed Solution

Define “Feedstock First Collection Point.”

### Rationale Supporting Proposed Solution

The “Feedstock First Collection Point” is a critical component of each feedstock’s supply chain, especially when multiple types of feedstocks are aggregated, as it is a point where mischaracterization can occur, ultimately resulting in incorrect CIs and reported fuel quantities. Feedstock First Collection Point defines the first collection point as one of the points in these feedstock’s chain of custody, separate from other points in the chain of custody, such as point of origin or fuel production facility.

## **Section 95481(a). Definition for “Feedstock Transport Mode”**

### Description of Problem

The current regulation does not include a definition for feedstock transport mode. This term requires a clear definition, as staff is proposing to verify data regarding the mode and distance used to transport feedstocks.

### Proposed Solution

Staff proposes to add a definition for feedstock transport mode.

### Rationale Supporting Proposed Solution

Staff is proposing to verify the mode and distance utilized to transport feedstocks utilized in a fuel pathway. The proposed definition ties these two parameters into one category for brevity sake.

### **Section 95481(a). Definitions Pertaining to Facilities**

#### **“Fuel Production Facility” and “Intermediate Facility”**

#### Description of Problem

The current regulation’s definition of “Production Facility” identifies the single facility in a fuel supply chain that produces the fuel in its final form, which may exclude some facilities which supply site-specific data for determination of the fuel pathway CI. However, the proposal is intended to require verification at more than one facility in a production chain. New terminology is required to differentiate facilities.

#### Proposed Solution

The definition of the term “Production Facility” is clarified to refer specifically to the “Fuel Production Facility.” The new term “Intermediate Facility” is defined to identify other facilities in the fuel pathway that have responsibilities under the regulation.

### Rationale Supporting Proposed Solution

The proposed changes to the definitions of facilities helps to identify and distinguish the facilities which have distinct requirements under the regulation.

### **Section 95481(a). Definitions Pertaining to *Feedstock Classification*.**

#### **“Animal Fat,” “Brown Grease,” “Fish Oil,” “Ineligible Specified Source Feedstocks,” “Technical Corn Oil”/“Distiller’s Corn Oil,” “Specified Source Feedstocks,” “Used Cooking Oil,” “Yellow Grease.”**

#### Description of Problem

Liquid biofuels can be produced from a multitude of feedstocks. For example, renewable diesel and biodiesel can be produced from one or more feedstocks derived from oilseed crops, the rendering of animal by-products, or from other food processing operations. Feedstocks may have widely varying CIs depending on whether they are a primary product or co-product of an agricultural crop, or a residue of a process that results in other primary products such as food or feed, or a waste material that would otherwise be collected for disposal. There may be increased demand for these low-CI feedstocks resulting in financial pressure to claim disadvantaged feedstocks as advantaged (specified source) feedstocks. Fuel pathway applicants need to know what is required to claim use of a particular feedstock.

#### Proposed Solution

Staff is proposing a set of definitions for feedstock classification requirements.

Staff is proposing individual definitions for specified source feedstocks (see section 95488.8(g) for a complete description of Specified Source feedstock), which would capture Animal Fat, Technical Corn Oil/Distiller's Corn Oil, Fish Oil, Used Cooking Oil (UCO), Brown Grease, and Yellow Grease. Staff is proposing to clarify how feedstocks that are mixtures should be reported; for example, Brown Grease is generally mixed with UCO and may be aggregated with UCO feedstock quantities in the CI summary calculator and transactions. Staff is proposing to require collection and retention of Chain-of-Custody evidence from the point of origin to support classification as Specified Source. Staff is also proposing to define Ineligible Specified Source Feedstocks for those specified source feedstocks that do not meet the chain-of-custody documentation requirements.

#### Rationale Supporting Proposed Solution

Under the proposal, the applicant for a pathway involving the use of a specified source feedstock must maintain records demonstrating chain-of-custody to demonstrate proper characterization, accurate quantity, and energy use for feedstock processing prior to delivery to the fuel production facility. That evidence must be provided to the verifier during the verification process, and to CARB upon request. The proposed definitions will assist applicants who wish to claim credits associated with low CI pathways under the LCFS program.

**Section 95481(a). Definition for “First Fuel Reporting Entity”**  
(see *Definitions pertaining to Classification of LCFS Participants*)

**Section 95481(a). Definition for “Fish Oil”**  
(see *Definitions pertaining to Feedstock Classification*)

**Section 95481(a). Definition for “Fixed Guideway System”**

#### Description of Problem

The current definition of fixed guideway system does not specify the types of electricity supply for such systems.

#### Proposed Solution

Expand the definition to include the overhead and underground electricity supply in the definition.

#### Rationale Supporting Proposed Solution

Expanding the current definition will broaden it and allow for the inclusion of more eligible vehicle types under this definition

**Section 95481(a). Definition for “FPC Obligated Amount”**  
(see *“Total Obligated Amount”*)

## **Section 95481(a). Definition for “Fuel Pathway”**

### Description of Problem

The current regulation provides instructions for applying for and maintaining certification of a fuel pathway, but does not explicitly define what a fuel pathway is.

### Proposed Solution

Staff proposes to add a definition for fuel pathway.

### Rationale Supporting Proposed Solution

The LCFS is built around fuel pathways, and it is fundamental that the extent of this term is clearly described.

## **Section 95481(a). Definition for “Fuel Pathway Applicant”**

*(see Definitions pertaining to Classification of LCFS Participants)*

## **Section 95481(a). Definition for “Fuel Pathway Holder”**

*(see Definitions pertaining to Classification of LCFS Participants)*

## **Section 95481(a). Definition for “Fuel Production Facility”**

*(see Definitions Pertaining to Facilities)*

## **Section 95481(a). Definition for “Fuel Reporting Entity”**

*(see Definitions pertaining to Classification of LCFS Participants)*

## **Section 95481(a). Definition for “Fuel Transport Mode”**

### Description of Problem

The current definition of Fuel Transport Mode does not incorporate the distance that the fuel was transported, and refers to the fuel delivery method that is expected to be used, rather than the method that was used (past tense). In addition, due to the proposed removal of the “Evidence of Fuel Transport Mode” section in the current regulation, a requirement is needed stating that the actual transport methodology and distance of finished fuel conforms to the entries in the certified fuel pathway.

### Proposed Solution

Staff proposes to modify the definition for Fuel Transport Mode. Staff proposes that the term refers to the transport methodology and distance utilized after certification of a fuel pathway, and that conformity with the original combination entered at initial pathway certification will be verified on an ongoing basis.

### Rationale Supporting Proposed Solution

See Rationale Supporting Proposed Solution for Feedstock Transport Mode for a description of why staff proposes to add transport distance to this definition. The proposed update to this definition is in line with the proposed approach for verifying fuel pathways on an ongoing basis.

### **Section 95481(a). Definition for “Green Tariff Shared Renewables”**

#### Description of Problem

New mechanisms are proposed to provide flexibility in accounting for renewable electricity used to serve EV and electrolysis loads, requiring use of terms new to the regulation.

#### Proposed Solution

Staff proposes to define the term Green Tariff Shared Renewables (GTSR). The GTSR is a program established by California Senate Bill 43 and administered by the California Public Utilities Commission (CPUC).<sup>45</sup>

#### Rationale Supporting Proposed Solution

The definition provides a reference to the specific program that staff proposes to recognize as an approved method of tracking renewable power claims for the purposes of LCFS crediting.

### **Section 95481(a). Definition for “Heavy-Duty Vehicle”**

#### Description of Problem

The current definition appeared to be circular.

#### Proposed Solution

Staff proposes to revise the definition.

#### Rationale Supporting Proposed Solution

The proposed definition is more straightforward.

### **Section 95481(a). Definition for “Independent Reviewer”**

*(see Definitions pertaining to Verification Service Requirements)*

### **Section 95481(a). Definition for “Ineligible Specified Source Feedstocks”**

*(see Definitions pertaining to Feedstock Classification)*

### **Section 95481(a). Definition for “Intermediate Facility”**

*(see Definitions pertaining to Facilities)*

### **Section 95481(a). Definition for “LCFS Credit Broker”**

#### Description of Problem

“Broker” is a very broad term and may refer to different participants that are related to the LCFS program in various capacities.

---

<sup>45</sup> Green Tariff/Shared Renewables Program website. Available at: <http://www.cpuc.ca.gov/General.aspx?id=12181>

### Proposed Solution

Staff is proposing to clarify that this term refers to a party registering in LRT-CBTS only for facilitating credit transfers between LRT-CBTS accounts. Thus, staff is changing “Broker” to “LCFS Credits Broker”.

### Rationale Supporting Proposed Solution

This change will avoid confusion between LCFS Credit Broker and any other party that may be referred to as a “broker” in another context. (For example, brokers for fuel or brokers for feedstock purchases.)

**Section 95481(a). Definition for “Lead Verifier,” “Mandatory Reporting Regulation,” “Material Misstatement of Carbon Intensity,” “Material Misstatement of Low-Complexity/Low-Energy-Use (LC/LEU) Refinery Data”, “Material Misstatement of Quarterly Fuel Quantity,” and “Material Misstatement of Project Data”**

*(see Definitions pertaining to Verification Service Requirements)*

**Section 95481(a). Definition for “Load-Serving Entity”**

### Description of Problem

Entities that serve electrical load are known as load-serving entities. This has not been properly defined in the LCFS regulation, and leaves some ambiguity as to which entities are considered load serving under the regulation.

### Proposed Solution

Staff proposes to add a definition of Load-Serving Entity.

### Rationale for Proposed Solution

Clearly defining the term “Load-Serving Entity” increases the clarity of the regulation. This allows regulation text to better define applicability for pathways that rely extensively on electricity, such as those for electric vehicles and hydrogen produced through electrolysis.

**Section 95481(a). Definition for “Multi-fuel Vehicle”**

### Description of Problem

The current regulation gives an example of a vehicle type that is not currently in commercial production.

### Proposed Solution

Staff proposes to update the example of a hydrogen and electric vehicle with the more familiar example of a plug-in hybrid electric vehicle.

### Rationale for Proposed Solution

Plug-in hybrid electric vehicles are common and should be familiar to most stakeholders, and therefore are a more useful example of a multi-fuel vehicle.

**Section 95481(a). Definition for “Nonconformance”**  
(see *Definitions pertaining to Verification Service Requirements*)

**Section 95481(a). Definition for “OPGEE” or “OPGEE Model”**

Description of Problem

The current regulation defines “OPGEE” or “OPGEE Model” using an April 6, 2015 version. However, this model has been updated since then.

Proposed Solution

Staff proposes to update the OPGEE Model.

Rationale for Proposed Solution

Updating the model ensure that staff is using the latest version that incorporates the most updated data and information available.

**Section 95481(a). Definition for “Opt-In Fuel Reporting Entity”**  
(see *Definitions pertaining to Classification of LCFS Participants*)

**Section 95481(a). Definition for “Opt-in Project”**

Description of Problem

Current regulation allows certain projects to opt into program and generate credits under project specific provisions. This includes refinery investment credit, innovative crude projects and hydrogen refinery projects. The proposal will also allow carbon capture and sequestration to opt in and generate credits. The current regulation does not define a term that refer to these project types.

Proposed Solution

Staff is proposing to define “Opt-in Projects” to cover all the voluntary projects that can opt in and generate credits.

Rationale for Proposed Solution

This change will help provide clear reporting requirements applicable to all project types covered under project specific crediting provisions.

**Section 95481(a). Definition for “Over-the-Counter”**

Description of Problem

Current regulation does not use or define the term “over-the-counter”. The proposal imposes requirements on “over-the-counter” transactions, and needs a definition.

Proposed Solution

Staff is proposing to define “Over-the-Counter”.

### Rationale Supporting Proposed Solution

In the current regulation all the credit transfers are over-the-counter. However, with staff's proposal to include clearing service providers some of the credit transfers reported in the LRT-CBTS could also be exchange based. Thus, it is important to clearly define the over-the-counter transfers to distinguish them from transfers occurring on exchanges.

#### **Section 95481(a). Definition for "Performance Review"**

### Description of Problem

In order to maintain the quality of verification services, prior and ongoing performance of verification bodies, lead verifiers, and certification systems must be periodically reviewed by CARB.

### Proposed Solution

Define "Performance Review."

### Rationale for Proposed Solution

Since periodic performance reviews by CARB are necessary to maintain verification program integrity, it is necessary to define the term and provide examples of documents that would be reviewed.

#### **Section 95841(a). Definition for "Positive Validation Statement" and "Positive Verification Statement"**

*(see Definitions pertaining to Verification Service Requirements)*

#### **Section 95481(a). Definition for "Producer"**

### Description of Problem

The definition of "Producer" in the current regulation states that it includes "out-of-state" producers, which does not seem necessary and therefore, this definition could be streamlined.

### Proposed Solution

Revise the definition to remove the part stating that it also includes "out-of-state" producers.

### Rationale for Proposed Solution

This change provides a more concise definition.

#### **Section 95481(a). Definition for "Production Facility"**

*(see Definitions pertaining to Facilities).*

#### **Section 95481(a). Definition for "Project Operator"**

*(see Definitions pertaining to Classification of LCFS Participants)*



**Section 95841(a). Definition for “Qualified Positive Validation Statement” and “Qualified Positive Verification Statement”**

*(see Definitions pertaining to Verification Service Requirements)*

**Section 95481(a). Definition for “Rack”**

Description of Problem

Current regulation does not define the term “Rack.” The proposal imposes requirements for fuel transacted above, across and below the “Rack”, and needs a definition.

Proposed Solution

Staff is proposing to define “Rack.”

Rationale Supporting Proposed Solution

Staff is proposing clarifying the responsibility for reporting fuel export in the LRT-CBTS in different scenarios. Staff has classified different scenarios with reference to the rack and thus it is important to have a definition for “Rack.”

**Section 95481(a). Definition for “Reasonable Assurance”**

*(see Definitions pertaining to Verification Service Requirements)*

**Section 95481(a). Definition for “Regulated Party”**

*(see Definitions pertaining to Classification of LCFS Participants)*

**Section 95481(a). Definition for “Regulated Entity”**

*(see Definitions pertaining to Classification of LCFS Participants)*

**Section 95481(a). Definition for “Renewable Fuel Standard”**

Description of Problem

The current regulation includes requirements for fuel pathway applications that include requirements from the Renewable Fuel Standard. However, the Renewable Fuel Standard is not defined in section 95481(a).

Proposed Solution

Define “Renewable Fuel Standard”

Rationale Supporting Proposed Solution

Defining “Renewable Fuel Standard” allow regulated entities to know what the program requires.

### **Section 95481(a). Definition for “Renewable Propane”**

#### Description of Problem

Since staff is proposing to allow renewable propane to generate credits under the LCFS, staff needs to define what is considered “Renewable Propane.”

#### Proposed Solution

Define “Renewable Propane”

#### Rationale Supporting Proposed Solution

Defining renewable propane will allow fuel-reporting entities to know what can generate credits as renewable propane under the LCFS.

### **Section 95481(a). Definition for “Reporting Party”**

*(see Definitions pertaining to Classification of LCFS Participants)*

### **Section 95481(a). Definition for “Single-fuel Vehicle”**

#### Description of Problem

The current regulation includes a definition for “single-fuel vehicle,” which staff believes is unnecessary

#### Proposed Solution

Staff proposes to remove the definition of single-fuel, and to maintain clarity by specifying “multi-fuel vehicle” when any provision pertains to an application that is not a single-fuel vehicle.

#### Rationale Supporting Proposed Solution

Staff believes this definition is unnecessary because 1) the term “single-fuel” is self-explanatory, and 2) the vast majority of existing vehicles are single-fuel, therefore it is more efficient and clear to designate only the exceptions (i.e. when there are special circumstances for multi-fuel vehicles). It can be assumed that provisions apply to any vehicle, unless otherwise specified. The deletion of the definition removes unnecessary language.

### **Section 95481(a). Definition for “Site-specific Data” and “Site-specific Input”**

#### Description of Problem

The current regulation does not include a definition for the terms Site-Specific Data or Site-Specific Input. The proposed regulation states that verification will be conducted for all site-specific inputs, and this term must be defined.

#### Proposed Solution

Staff proposes to add a definition for Site-Specific Data and Site-Specific Input.

#### Rationale Supporting Proposed Solution

With the proposed inclusion of third-party verification, inputs to fuel pathways that necessitate verification must be clearly identified. The proposed definition accomplishes this by designating inputs that necessitate verification as site-specific data/inputs.

#### **Section 95481(a). Definition for “Specified Source Feedstocks”** *(see Definitions Pertaining to Feedstock Classification)*

#### **Section 95481(a). Definition for “Staff”**

#### Description of Problem

The current regulation refers to “staff,” but it is not defined in the regulation.

#### Proposed Solution

Define “Staff”

#### Rationale Supporting Proposed Solution

Defining “staff” clarifies who is referred to as “staff” in the LCFS.

#### **Section 95481(a). Definition for “Technical Corn Oil”/“Distiller’s Corn Oil”** *(see Definitions Pertaining to Feedstock Classification)*

#### **Section 95481(a). Definitions for “Total Obligated Amount” and “Total Amount”**

#### Description of Problem

The obligation in the regulation refers to the ability of fuel to generate credits or deficits. Accordingly, obligated amount refers to the quantity of fuel that generates credits or deficits when reported in the LRT-CBTS and non-obligated amount refers to the fuel that is stripped of its ability to generate credits or deficits in the LRT-CBTS (i.e., the credit or deficit for that fuel has already been generated and claimed by another party). To ensure accurate accounting of credits, deficits and fuel quantities in the program the LRT-CBTS have a system check in place, which does not allow an entity to take out any extra obligated or non-obligated fuel quantities from their inventories than what they reported as adding to their inventories. The current regulation requires obligated quantities to be validated in the LRT-CBTS but does not provide clear requirements for total fuel quantities.

#### Proposed Solution

Staff is proposing adding definition of “Total Obligated Amount” and “Total Amount” which will help provide clear requirements for accurate accounting of obligated and non-obligated fuel quantities in the LRT-CBTS. Total Obligated Amount replaces “FPC Obligated Amount” in the current regulation.

### Rationale Supporting Proposed Solution

The proposed definitions classify fuel quantities based on the transaction types used for reporting in the LRT-CBTS. This streamlines the regulation with the LRT-CBTS, thus making it possible to translate the regulatory requirements into system functionality.

### **Section 95481(a). Definition for “Transaction Quantity”**

#### Description of Problem

Since staff is proposing to change the reporting units for CNG and L-CNG from standard cubic feet (scf) to Therms, the unit scf is no longer relevant to reporting transaction quantities for CNG and L-CNG.

#### Proposed Solution

Staff is proposing to replace scf with Therms in the definition of “Transaction Quantity.”

### Rationale Supporting Proposed Solution

The change maintains consistency and clarity in the regulation.

### **Section 95481(a). Definition for “Transaction Type”**

#### Description of Problem

Based on the proposal, definition of some transaction types in the current regulation need to be updated for clarification. Definition for new transaction types also need to be added for the new fuel types being proposed to be included in the program.

#### Proposed Solution

Staff is proposing to update the following transaction type definitions for clarification: “Production for Import”, “Import”, “Purchased with Obligation”, “Purchased without Obligation”, “Sold with Obligation”, “Sold without Obligation” and “Export”.

Staff is proposing to replace definition of “EV Charging” with definition of “EV Charging – Grid,” “EV charging – Non-Grid,” and “EV charging – TOU.”

Staff is proposing to rename “Fixed Guideway Charging” to “Fixed Guideway Electricity Fueling.”

Staff is proposing to replace definition of “Forklift Fueling” with definition of “Forklift Electricity Fueling” and “Forklift Hydrogen Fueling”.

Staff is proposing to add following new transaction type definitions: “eTRU Fueling”, “Fuel Cell Vehicle (FCV) Fueling”, “Fuel Cell Vehicle (FCV) Fueling – TOU” and “Propane Fueling”

### Rationale Supporting Proposed Solution

Defining the different transaction types help establish clear reporting requirements for the fuel reporting entities.

## **Section 95481(a). Definition for “Uncertainty”**

### Description of Problem

The proposal requires verifiers to evaluate uncertainty when assessing the risk of misreporting. That term should be defined to guide verifiers.

### Proposed Solution

Define “Uncertainty.”

### Rationale Supporting Proposed Solution

The definition of “uncertainty” is necessary to ensure that those subject to the regulation are able to understand and interpret the regulation correctly, and to avoid ambiguity and improve compliance with the regulation.

## **Section 95481(a). Definition for “Used Cooking Oil”**

*(see Definitions pertaining to Feedstock Classification)*

## **Section 95481(a). Definition for “Validation”**

*(see Definitions pertaining to Verification Service Requirements)*

## **Section 95481(a). Definition for “Validation Statement”**

*(see Definitions pertaining to Verification Service Requirements)*

## **Section 95481(a). Definition for “Verification”**

*(see Definitions pertaining to Verification Service Requirements)*

## **Section 95481(a). Definition for “Verification Body”**

*(see Definitions pertaining to Verification Service Requirements)*

## **Section 95481(a). Definition for “Verification Services,” “Verification Statement,” “Verification Team,” and “Verifier Review”**

*(see Definitions pertaining to Verification Service Requirements)*

## **Section 95481(a). Definitions pertaining to *Verification Service Requirements***

**“Adverse Validation Statement” and “Adverse Verification Statement,” “Independent Reviewer,” “Lead Verifier,” “Mandatory Reporting Regulation” or “MRR,” “Material Misstatement of Carbon Intensity,” “Material Misstatement of Low-Complexity/Low-Energy-Use (LC/LEU) Refinery Data,” “Material Misstatement of Project Data,” “Material Misstatement of Quarterly Fuel Quantity,” “Nonconformance,” “Positive Validation Statement” and “Positive Verification Statement,” “Qualified Positive Validation Statement” and “Qualified Positive Verification Statement,” “Reasonable Assurance,” “Validation,” “Validation Statement,”**

**“Verification,” “Verification Body,” “Verification Services,” “Verification Statement,” “Verification Team,” “Verifier Review.”**

Description of Problem

The addition of a system for third-party verification requires new terms to define entities responsible for verifications, entities conducting LCFS verifications, verification services, and verification outcomes.

Proposed Solution

Staff is proposing to define the following terms:

Definitions to capture entities conducting LCFS verifications: “Independent Reviewer,” “Lead Verifier,” “Verification Body,” and “Verification Team.”

Definitions to capture verification services: “Mandatory Reporting Regulation” or “MRR,” “Material Misstatement of Carbon Intensity,” “Material Misstatement of Low-Complexity/Low-Energy-Use (LC/LEU) Refinery Data,” “Material Misstatement of Project Data,” “Material Misstatement of Quarterly Fuel Quantity,” “Nonconformance,” “Reasonable Assurance,” “Validation,” “Validation Statement,” “Verification,” “Verification Body,” “Verification Services,” “Verification Statement,” “Verification Team, and “Verifier Review.”

Definitions to capture validation and verification outcomes: “Adverse Validation Statement” and “Adverse Verification Statement,” “Positive Validation Statement” and “Positive Verification Statement,” “Qualified Positive Validation Statement” and “Qualified Positive Verification Statement.”

Rationale Supporting Proposed Solution

Addition of terms and definitions for the proposed verification program is necessary to convey legal meaning. Terms and definitions for the LCFS verification program are consistent with existing terms and definitions in MRR and the Cap-and-Trade Regulation, but modified where necessary to reflect the needs of the LCFS.

**Section 95481(a). Definition for “Yellow Grease”**  
*(see Definitions Pertaining to Feedstock Classification)*

**Section 95481(b). Acronyms.**

Description of Problem

Additional acronyms are needed to account for proposed amendments to this regulation which includes the option for aviation fuels to participate with the LCFS and the addition of a mandatory third-party verification program. Some acronyms are used in the current regulation but do not appear in 95481(b).

Proposed Solution

Staff is proposing to incorporate the following acronyms:

- “AJF” means alternative jet fuel. Under the proposed amendments, AJF would be an opt-in fuel (one that can generate credits if producers or importers choose to participate in the LCFS program). It is not included as one of the credit-generating fuels in the current LCFS regulation.
- “AFP” means Alternative Fuel Portal.
- “CARB” means California Air Resources Board. This acronym is used in the current regulation but does not appear in the list of acronyms.
- “CCM” means Credit Clearance Market. This acronym is used in the current regulation but does not appear in the list of acronyms.
- “DCO” means Distiller’s Corn Oil, also known as Technical Corn Oil. Existing pathways under the current LCFS regulation utilize this feedstock, but it is currently referred to as “corn oil” which may be confused with food grade corn oil.
- “EDU” means Electrical Distribution Utility. This acronym is used in the current regulation but does not appear in the list of acronyms.
- “eTRU” means Electric Transport Refrigeration Unit. Under the proposal, eTRU are eligible for generating credits in LCFS.
- “FCV” means fuel cell vehicle. Under staff’s proposal, hydrogen dispensed at a fueling station designed for fueling hydrogen fuel cell electric vehicles must be reported using “FCEV fueling”.
- “FPC” means fuel pathway code. This acronym is used in the current regulation but does not appear in the list of acronyms.
- “FSE” means fueling supply equipment. Under staff’s proposal, FSE must be registered for certain fuel types.
- “GTSR” means the Green Tariff Shared Renewables program. The GTSR is one possible option for using renewable, low-CI electricity for some fuel pathways. The GTSR is a program implemented by utilities to account for additional renewable electricity use by customers subscribed to the tariff. Tariff customers can use their subscription to lower the carbon intensity for specific pathway applications for electric vehicles and hydrogen production through electrolysis.
- “H<sub>2</sub>” means hydrogen. This acronym is used in the current regulation but does not appear in the list of acronyms.
- “LCA” means life cycle analysis. This acronym is used in the current regulation but does not appear in the list of acronyms.
- “LSE” means load-serving entity. The proposal provides eligibility requirements for electricity supplied by load serving entities to be eligible for generating credits.
- “LVP” means LCFS Verification Portal. The LVP describes a tool with new functionality in the LCFS data management system.
- “MRR” Mandatory Greenhouse Gas Reporting Regulation.
- “NG” means natural gas. This acronym is used in the current regulation but does not appear in the list of acronyms.
- “RFS” means the Renewable Fuel Standard. This acronym is used in the current regulation but does not appear in the list of acronyms.
- “RNG” means renewable natural gas, also referred to as biomethane.

- “SMR” means steam methane reformation, a process of utilizing natural gas as a feedstock to produce hydrogen. SMR is a current fuel pathway but does not appear in the list of acronyms.
- “UCO” means Used Cooking Oil, a feedstock used for production of biodiesel, renewable diesel, and alternative jet fuel. This term is used in the current regulation but not abbreviated as its acronym.
- “TOU” means time-of-use. For electricity-heavy pathways, such as electric vehicle charging and hydrogen production through electrolysis, there are specific times of day that using more electricity will increase renewable electricity utilization due to curtailment. TOU is referred to several times throughout the regulation.
- “U.S. EPA” means the U.S. EPA. This acronym is used in the current regulation but does not appear in the list of acronyms.

Staff is proposing to change “iLUC” to “LUC”. “LUC” means land use change and includes direct and indirect effects.

#### Rationale Supporting Proposed Solution

Due to the length and complexity of the proposed amendments, identifying commonly used acronyms and new fuels added to the list of opt-in fuels, it is more efficient and effective to list them in the front of the document rather than separately each time they occur.

### **SECTION 95482. FUELS SUBJECT TO REGULATION.**

#### **Section 95482(a)(7). A fuel blend containing hydrogen (“hydrogen blend”)**

##### Description of Problem

The current regulation lists a hydrogen blend as one of the fuels which is subject to the regulation. It was expected in the past that hydrogen may be blended with natural gas for combustion in natural gas vehicles. Staff is unaware of any use of hydrogen in this manner, nor is it known to be blended with any other transportation fuels in California. Furthermore, existing provisions do not provide for any such blend; for example, section 95486(b) in the current regulation, describing credit generation, such as the use of hydrogen EERs, may be inappropriate for a hydrogen blend.

##### Proposed Solution

Staff is proposing to delete hydrogen blends from the list of fuels explicitly called out as subject to the regulation. Note that this is a non-substantive change because if an entity were to begin to market a hydrogen blend, the fuel would be captured under (13) of this subsection “any other liquid or non-liquid fuel.”

##### Rationale Supporting Proposed Solution

Staff investigated whether this fuel type was currently in use or whether there is any expectation that it would likely be utilized in the future. The removal of hydrogen blends from this list removes confusion and ensures that credits would not be inaccurately calculated in the event that a hydrogen-natural gas blend combusted in a natural gas



engine might otherwise attempt to claim the higher amount of credits associated with the more efficient use of hydrogen in a fuel cell vehicle, for which the EERs in Table 4 are intended.

### **Section 95482(a)(10). Neat biomass-based diesel (“B100 or R100”)**

#### Description of Problem

The current regulation appears to only recognize neat biodiesel as a neat biomass-based diesel, but neat renewable diesel is also subject to the regulation as it falls under the biomass-based diesel category.

#### Proposed Solution

Staff is proposing to also list “R100” as a neat biomass-based diesel. Note that this is a non-substantive change because neat renewable diesel is already subject to the regulation.

#### Rationale Supporting Proposed Solution

Listing R100 as an example of neat biomass-based diesel along with B100 will reduce any misinterpretation that neat renewable diesel is not subject to the regulation.

### **Section 95482(a)(11). Alternative Jet Fuel**

#### Description of Problem

One of the primary purposes for this rulemaking is to broaden the list of fuels subject to the LCFS regulation in order to incent greenhouse gas (GHG) reductions in strategic areas where decarbonization will be important to meet long-term targets. Aviation is one such area that has been identified as a significant and growing source of GHG emissions:

Currently, GHG emissions from aviation contribute to approximately 2 to 3 percent of the total global emissions, and the amount of emissions is expected to grow around 3 to 4 percent a year<sup>46</sup>. There are relatively few mechanisms for the airline industry to directly reduce GHG emissions other than through efficiency improvements and use of lower-CI fuels.

#### Proposed Solution

Staff is proposing to allow alternative jet fuel to generate credits under the LCFS by adding it to the list of types of transportation fuels to which the LCFS applies.

#### Rationale Supporting Proposed Solution

The rationale for this change is presented in Chapter II of this Staff Report. The supporting rationale for allowing AJF to generate credits under the LCFS includes: the potential GHG benefits of greater use of AJF; the potential increase in investment in facilities that produce both AJF and renewable diesel and resulting increase in

---

<sup>46</sup> See <https://www.icao.int/environmental-protection/Pages/aircraft-engine-emissions.aspx>.

availability of those fuels; potential reductions in criteria pollutant emissions in California near airports.

### **Section 95482(a)(12). Propane**

#### Description of Problem

One of the primary purposes for this rulemaking is to broaden the list of fuels subject to the LCFS regulation in order to incent GHG reductions. In the current regulation, propane is listed as an exempt fuel and cannot participate in the LCFS. The propane industry has asked CARB to consider removing the exempt status for propane used as a transportation fuel.

#### Proposed Solution

Staff is proposing to add propane to the list of types of transportation fuels to which the LCFS applies. This means that fossil-based propane dispensed for transportation use in California will be required to be reported, and will generate either credits or deficits under the LCFS depending on its CI value relative to the appropriate benchmark CI for that year.

Please see also the exemption for specific applications relevant to propane in the proposed solution for section 95482(d)(3).

#### Rationale Supporting Proposed Solution

The rationale for this change is presented in Chapter II of this Staff Report. The supporting rationale for including propane includes: the potential GHG and criteria air pollutant emission benefits, the expected growth of propane as an alternative fuel, and the emergence of pathways for renewable propane.

### **Section 95482(b)(2). Hydrogen**

#### Description of Problem

Senate Bill (SB) 1505 requires that CARB adopt regulations to ensure that the production and direct use of hydrogen fuels for motor vehicle use in the state contributes to a reduced dependence on petroleum, as well as reductions in greenhouse gas emissions, criteria air pollutant emissions, and toxic air contaminant emissions.<sup>47</sup>

#### Proposed Solution

Staff is proposing to remove hydrogen from the list of opt-in fuels which means that regulated parties will be required to report (and generate credits or deficits for) hydrogen fuel dispensed in California for transportation purposes. However, staff's proposal leaves in place the low volume exemption threshold in the current regulation, meaning this requirement would become effective immediately following a 12-month period in

---

<sup>47</sup> California Senate Bill 1505, Lowenthal, 2006. Available at: <https://www.arb.ca.gov/msprog/hydprod/hydprod.htm>

which the mass of hydrogen fuel dispensed in California for transportation purposes exceeds 3,500 metric tons (420 million MJ).

#### Rationale Supporting Proposed Solution

By changing the opt-in status of hydrogen and requiring regulated parties to report all quantities of hydrogen under the LCFS, CARB will be able to use the LCFS reporting framework to monitor statewide compliance with the greenhouse gas emission and renewable energy resource requirements of California SB 1505.

### **Section 95482(b)(3). A hydrogen blend**

#### Description of Problem

Please see the problem for section 95482(a)(7).

#### Proposed Solution

Staff is proposing to delete hydrogen blends from the list of alternative fuels that may opt into the regulation.

#### Rationale Supporting Proposed Solution

Please see the rationale for section 95482(a)(7).

### **Section 95482(b)(4). Fossil CNG derived from North American sources**

#### Description of Problem

Fossil CNG derived from North American sources is currently an opt-in fuel because it is presumed to have a CI that meets the standard in every year through 2020. As the CI standard continues to decline beyond 2020, however, staff anticipates that the average CI of fossil CNG will exceed the standard and become a deficit-generating fuel.

#### Proposed Solution

Staff is proposing to delete fossil CNG from the list of alternative fuels that may opt into the regulation.

Please see also the exemption for specific applications relevant to fossil CNG in the proposed solution for section 95482(d)(3).

#### Rationale Supporting Proposed Solution

The rationale for this change is presented in Chapter II of this Staff Report.

### **Section 95482(b)(5). Alternative Jet Fuel**

#### Description of Problem

Please see the problem for section 95482(a)(11).

### Proposed Solution

Staff is proposing to allow alternative jet fuel to generate credits as an opt-in fuel under the LCFS by adding it to the list of fuels that may opt into the program to generate credits.

### Rationale Supporting Proposed Solution

Please see the rationale for section 95482(a)(11).

## **Section 95482(b)(6). Renewable Propane**

### Description of Problem

Please see the problem for section 95482(a)(12).

### Proposed Solution

Staff is proposing to add renewable propane to the list of fuels that may opt into the program to generate credits.

### Rationale Supporting Proposed Solution

Staff anticipate the inclusion of renewable propane as an opt-in fuel in the LCFS may lead to its increased use as a transportation fuel in California. Renewable propane is chemically indistinct from fossil propane and can therefore be used by all existing propane-powered vehicles without the need for modification. Renewable propane is a byproduct of renewable diesel and/or alternative jet fuel production, making it a lower carbon alternative to fossil propane and petroleum products. Depending on the type of feedstock used, renewable propane could provide a reduction in CI of up to 80 percent over conventional blends.<sup>48</sup>

For additional information on propane in the LCFS, please see Chapter II of this Staff Report and the rationale for section 95482(a)(12).

## **Section 95482(c). Exemptions for Specific Fuels**

### Description of Problem

The current regulation only includes exemptions for specific alternative fuels.

### Proposed Solution

Staff is proposing to remove the reference to alternative fuels and list all fuels – both conventional and alternative – that are exempt.

### Rationale Supporting Proposed Solution

By removing the reference to alternative fuels, conventional fuel, such as convention jet fuel and aviation fuel, will be included in the list of exemptions.

---

<sup>48</sup> Estimated based on conversion of used cooking oil to renewable diesel.

### **Section 95482(c)(2). Liquefied petroleum gas (LPG or “propane”)**

#### Description of Problem

Please see the problem for section 95482(a)(12).

#### Proposed Solution

Staff is proposing to remove propane from the list of fuels exempt from the LCFS. This means that its use as a transportation fuel will generate either credits or deficits under the LCFS.

#### Rationale Supporting Proposed Solution

Please see the rationale for section 95482(a)(12).

### **Section 95482(c)(2). Conventional jet fuel or aviation gasoline**

#### Description of Problem

Currently, the LCFS regulation does not apply to any transportation fuel used in aircraft. Since staff is proposing to allow alternative jet fuel to opt into the LCFS to generate credits, to clarify that conventional jet fuel and aviation gasoline remain outside of the LCFS, those fuels must be specifically exempted from the program.

#### Proposed Solution

Staff is proposing to add conventional jet fuel and aviation gasoline to the list of exemptions for specific fuels. This means that conventional jet fuel or aviation gasoline would not be subject to the regulation and would, therefore, not generate deficits.

#### Rationale Supporting Proposed Solution

Subjecting aircraft fuels to annual carbon intensity standards would raise federal preemption issues. However, CARB has the authority to amend the LCFS regulations to create incentives to promote the use of low carbon fuels in aircraft by allowing credit for such fuels. By promoting the voluntary production and use of alternative jet fuel, CARB would not be regulating aircraft fuels, but rather would simply be creating opportunities for airlines to better support California’s GHG objectives.

### **Section 95482(c)(3). Military use of CARBOB and Diesel**

#### Description of Problem

The LCFS currently exempts all fuels supplied for use in military tactical vehicles and support equipment from both credit and deficit generation. Producers of renewable fuels used in these applications have expressed concern that this provision reduces their incentives to sell low carbon fuels to the military. These producers have requested opt-in status for the alternative fuels sold for use in these military applications. However, staff needs to ensure that conventional fuels used in these applications are still exempt from the program.

### Proposed Solution

Staff is proposing to add any deficit-generating fuel used in military tactical vehicles and tactical support equipment to the list of exemptions for specific fuels. This means that these fuels would not be subject to the regulation and would, therefore, not generate deficits.

### Rationale Supporting Proposed Solution

By exempting deficit-generating fuels used in these applications, the military will not be subject to the declining standards of the LCFS, which may raise federal preemption issues. However, CARB has the authority to amend the LCFS regulations to create incentives to promote the use of low carbon fuels in military tactical vehicles and support equipment by allowing credit for such fuels. By promoting the voluntary use of alternative fuels in these applications, CARB would be creating opportunities for producers to better support California's GHG objectives.

## **Section 95482(d)(1). Military use of alternative fuels**

### Description of Problem

Currently, the LCFS regulation exempts military tactical vehicles and tactical support equipment from both credit and deficit generation. However, staff is proposing to allow alternative fuel used in these applications to generate credits under the LCFS, and therefore this exemption must be removed.

### Proposed Solution

Staff is proposing to remove military tactical vehicles and tactical support equipment from the list of exemptions for specific applications. Together with the previously discussed changes for 95482(c)(3), this will allow renewable fuels to earn credit for use in these applications, while *exempting* conventional fuels from generating deficits.

### Rationale Supporting Proposed Solution

Please see the rationale for section 95482(c)(3) above.

## **Section 95482(d)(3). Exemptions for School buses**

### Description of Problem

Because staff is proposing to 1) remove the exempt status for propane used as a transportation fuel, and 2) remove the opt-in status of fossil CNG, providers of these fuels will be required to report dispensed quantities to the LCFS. Because these fuels are likely to become deficit-generating fuels when used as a diesel substitute in heavy-duty applications, this would incur a cost to public fleets such as school buses, unless the fleets transition to using renewable sources of these fuels.

Please see Chapter II, and the problem, solution and rationale for sections 95482(a)(12) and 95482(b)(4), of this Staff Report for more information on the proposed changes to CNG and propane.

### Proposed Solution

Staff is proposing to add existing school buses using fossil CNG and propane to the list of exemptions for specific applications. This will allow renewable propane and biomethane to earn credit for use in these applications, while *exempting* the fossil fuels from generating deficits for reporting entities that are school bus fleet operators for these vehicles. The exemption will apply only to school buses purchased before 2020.

### Rationale Supporting Proposed Solution

Staff proposes this targeted exemption to avoid making school districts mandatory participants and deficit generators under the regulation for vehicles they had acquired prior to the proposed amendments. The proposal leaves in place the incentive for school bus fleet operators to switch to renewable fuels and generate credits.

## **Section 95482(d)(4). Exemptions for Aircraft**

### Description of Problem

Currently, the LCFS regulation does not apply to any transportation fuel used in aircraft. Since staff is proposing to allow alternative jet fuel to opt into the LCFS to generate credits, alternative jet fuel used in aircrafts must not be exempt.

### Proposed Solution

Staff is proposing to remove aircrafts from the list of exemptions for specific applications. Together with the previously discussed changes for 95482(c), this will allow renewable fuels to earn credit for use in these applications, while *exempting* conventional fuels from generating deficits.

### Rationale Supporting Proposed Solution

Please see the rationale for both section 95482(a)(11) and section 95482(c)(2).

## **SECTION 95483. FUEL REPORTING ENTITIES.**

### **Section 95483. Restructuring and Strikeout**

### Description of Problem

The purpose of this section is to designate the entities responsible for reporting fuel ("Fuel Reporting Entities") in the LRT-CBTs and generating credits or deficits (Credit and Deficit Generators). The existing section needed an update to reflect the proposed changes to the terminology discussed in section 95481(a). *Definitions pertaining to Classification of LCFS Participants.*

### Proposed Solution

Staff is proposing to restructure and update the section to more clearly designate the Fuel Reporting Entities (i.e. the entities responsible for reporting fuel transactions in the LRT-CBTS) and the rules related to the eligibility to generate credits or deficits for each type of transportation fuel. The section is divided into the following three fuel types: (a) liquid fuels which include fossil fuels (gasoline and diesel fuel), liquid alternative fuels

(ethanol, biomass-based diesel and alternative jet fuels), and blends of liquid alternative and fossil fuels; (b) gaseous fuels which include fossil and renewable natural gas fuels (CNG, LNG and L-CNG), propane and hydrogen; and (c) electricity.

Using the new terminology for classification of LCFS participants, the section designates the First Fuel Reporting Entity for all fuel types, which is also the party with the initial ability/requirement to be the Credit/Deficit Generator. For some fuels, flexibility to transfer the status as credit or deficit generator to another entity exists in the current regulation. This creates additional fuel reporting entities in the system. The proposed changes maintain that flexibility for liquid fuels and add separate flexibility for gaseous fuels to contractually designate another party to act as the LCFS Fuel Reporting Entity.

#### Rationale Supporting Proposed Solution

Clearly designating the entities responsible for reporting fuel transactions and generating credits and deficits in the LRT-CBTS is imperative to having complete and accurate reporting in the program. Staff's goal is to avoid any misreporting, double reporting, or incomplete reporting resulting from confusion over LCFS reporting responsibility among entities involved in the fuel supply chain. The proposed changes more clearly identify the fuel reporting, credit and deficit generating parties for each fuel type and the rules governing when these roles may be transferred to other parties.

### **Section 95483(a)(1)(C). Fuel Reporting Entities for Alternative Jet Fuel or an Alternative Jet Fuel Blend**

#### Description of Problem

Since staff is proposing to allow alternative jet fuel to generate credits under the LCFS for the first time, fuel reporting entities for alternative jet fuel or alternative jet fuel blends must be defined.

#### Proposed Solution

Staff is proposing to define the first fuel reporting entity for alternative jet fuel, whether or not it is blended with conventional jet fuel, as the producer or importer of the alternative fuel. Opt-in alternative jet fuel pathways would be eligible to generate credits for the total volume loaded to an aircraft in California, whether the destinations are in California or out of the state. The conventional jet fuel component need not be reported.

#### Rationale Supporting Proposed Solution

This approach is similar to that taken for all other liquid fuels. For all low carbon alternative liquid fuels, the producer or importer is the most logical entity to designate as the first fuel reporting entity with the right to generate credits. This is because either they are the party that directly incurs the cost of constructing and operating the alternative fuel production facility that the LCFS is trying to incentivize or, in the case of importers, they are the closest Californian entity in the supply chain to that producer.<sup>49</sup>

---

<sup>49</sup> Note that out-of-state producers can chose to opt-in to the program per section 95483.1.



Therefore, staff proposes following the same model that has been successful in promoting the use of other alternative liquid fuels for alternative jet fuels.

Allowing credit to be generated for all alternative jet fuel uploaded to an aircraft in California, rather than restricting credit to fuel used on intrastate flights only, avoids the unnecessary complexity of requiring separate storage and tracking of alternative jet fuel at airports. Because climate change is a global problem and not one restricted to California airspace, staff does not believe placing restrictions on the geographical use of the fuel is warranted. Similar to other alternative fuels under the LCFS, the proposed amendments allow the right to generate credits to be passed downstream upon sale of the fuel. This flexibility may be desirable for some entities.

For more information on why conventional jet fuel is exempt from the LCFS, please see Chapter II of this Staff Report and the rationale for section 95482(c)(2).

### **Section 95483(a)(2)(A)(4). No Transfer of Credit or Deficit Generator Status Below the Rack**

#### Description of Problem

The current LCFS regulation allow a fuel reporting entity to transfer its status as a credit or deficit generator along with the ownership of fuel covered under LCFS (fuel with obligation) to another entity below the rack. In such cases, entity acquiring the ownership of fuel with obligation becomes the fuel reporting entity and is required to report the fuel transaction in the LRT-CBTS. This obligation to report could increase the administrative burden for smaller companies that mostly acquire the fuel below the rack.

#### Proposed Solution

Staff is proposing to limit fuel reporting entity's ability to transfer its status as credit or deficit generator only to the entities acquiring ownership of fuel above the rack.

#### Rationale Supporting Proposed Solution

This change will minimize the reporting requirements for small entities acquiring fuel below the rack. Recipients of fuel below the rack will still be required to report the export of fuel in the LRT-CBTS if that fuel has already been reported in the LRT-CBTS (see the problem, solution, and rationale for section 95483(a)(4) pertaining to fuel exporters).

### **Section 95483(a)(3). Transfer Period**

#### Description of Problem

When a credit or deficit generator reports fuel quantity in LRT-CBTS, the number of credits or deficits generated are proportional to the difference between the CI of fuel and the CI standard for the year. If, in the following year, an entity passes along the ownership of the same liquid fuel quantity with the credit or deficit generator status to another entity, the number of credits or deficits deducted in the transferee's account

would be different and based on that year's CI standard. Such delayed transactions could result in incorrect accounting of credits and deficits in the program.

#### Proposed Solution

To avoid such situation and ensure an accurate accounting of credits and deficits in the program, the transfer of credit or deficit generator status for a liquid fuel quantity should not occur inter-year and, ideally, would be limited to a single quarter. However, current commercial practice requires more flexibility, so Staff proposes limiting the transfer period for the credit or deficit generator status to another entity to only two quarters.

This means if the ownership of the fuel with obligation is received produced or purchased in Q1, then it can be transferred with obligation (the ability to generate credits or deficits) no later than the end of Q2. After that, ownership of the fuel can still be transferred without obligation (meaning, without the ability to generate the associated credits by the buyer), and the resulting credits or deficits would be retained by the upstream entity, which can transfer any credits separately in the LRT-CBTS.

#### Rationale Supporting Proposed Solution

This change is to minimize instances where a fuel quantity reported in one compliance year is reported again in the following compliance year resulting in different number of credits or deficits for the same amount of fuel in each year.

### **Section 95483(a)(4). Designation of Fuel Exporter**

#### Description of Problem

The LCFS regulation requires entities exporting fuel that has already been reported in the LRT-CBTS to report the export in the LRT-CBTS. The current regulation could more clearly define who is responsible to report exports in all scenarios.

#### Proposed Solution

The staff is proposing to more clearly designate the entity responsible for reporting exports in the LRT-CBTS in different scenarios. Staff is proposing to separately establish the fuel exporter for fuel transactions occurring above, across, or below the rack.

#### Rationale Supporting Proposed Solution

Clearly designating entity responsible for reporting exports in the LRT-CBTS is imperative to having complete and accurate reporting of the exports in the program. It avoids any misreporting, double reporting, or incomplete reporting of exports resulting from confusion over the reporting responsibility among entities involved in the fuel supply chain.

## **Section 95483(b)(1)(C) and (D). Fuel Reporting Entities for Propane used as a Transportation Fuel**

### Description of Problem

Since Staff is proposing to include propane used as a transportation fuel in the LCFS for the first time, the rule needs to define the fuel reporting entities for propane.

### Proposed Solution

Staff is proposing to define the first fuel reporting entity for renewable propane, whether or not it is blended with fossil propane, as the producer or importer of the renewable fuel. For fossil propane, whether or not it is blended with renewable propane, the entity that owns the propane fueling equipment at the facility at which the fossil propane and renewable propane blend is dispensed to motor vehicles for their transportation use is the fuel reporting entity. This model has worked well for natural gas fuels and we propose to extend it to propane as well.

### Rationale Supporting Proposed Solution

The renewable propane producer is the most logical entity to designate as the first fuel reporting entity with the right to generate credits because they incur the cost of constructing and operating the production facility and producing the alternative fuel. If the producer does not wish to opt-in to the program, the importer or some other party contractually related to the producer may still provide the appropriate incentive.

For fossil propane, the entity that owns the propane fueling equipment at the facility at which the fossil propane is dispensed to motor vehicles for transportation use is the most logical to become the fuel reporting entity. Fossil propane is produced in large quantities for numerous applications not involving transportation and does not need the incentive provided by the LCFS to be produced. Designating the owner of the fueling equipment to be the first fuel reporting entity places the responsibility for reporting at the point of dispensing to a vehicle and therefore ensures accurate reporting of fossil propane use without complex tracking from the producer.

## **Section 95483(b)(1)(D). First Fuel Reporting Entity for Fossil LNG used as a Transportation Fuel**

### Description of Problem

Current regulation designates first fuel reporting entity for fossil LNG as the party that owns the fossil LNG right before it is transferred to storage at the facility at which the liquefied blend is dispensed to motor vehicles for their transportation use. This is inconsistent with designation of first fuel reporting entity for other gaseous fossil fuels.

### Proposed Solution

Staff is proposing for fossil LNG, whether or not it is blended with renewable LNG, the entity that owns the fueling equipment at the facility at which the fossil LNG or a blend of fossil and renewable LNG blend is dispensed to motor vehicles is the fuel reporting

entity. This model has worked well for fossil CNG and staff proposes to extend it to fossil LNG as well.

#### Rationale Supporting Proposed Solution

For fossil LNG, the entity that owns the fueling equipment at the facility at which the fossil LNG is dispensed to motor vehicles for transportation use is the most logical to become the fuel reporting entity. Designating the owner of the fueling equipment to be the first fuel reporting entity places the responsibility for reporting at the point of dispensing to a vehicle and therefore ensures accurate reporting of fossil LNG quantities without complex tracking from the producer.

### **Section 95483(b)(1)(E). Fuel Reporting Entities for Hydrogen used as a Transportation Fuel**

#### Description of Problem

The purpose of this subsection is to establish the fuel reporting entity and credit generators for hydrogen. The current rule is unclear as to exactly what it means to produce “finished hydrogen fuel” and therefore the appropriate reporting party and credit generator for hydrogen lacks clarity.

#### Proposed Solution

Staff is proposing changes to clarify who is responsible for reporting hydrogen fuel and generating credits in the LRT-CBTS. Staff is proposing that the station owner be the first entity required to report and generate credits or deficits for hydrogen dispensed in vehicles. If the station owner wishes to avoid this role, they can contractually designate another party, such as the hydrogen fuel provider, to report fuel and generate credits in the LRT-CBTS through the flexibility allowed in this regard for all gaseous fuels.

#### Rationale Supporting Proposed Solution

Clearly designating the entity responsible for reporting fuel and generating credits or deficits for hydrogen in the LRT-CBTS is imperative to having complete and accurate reporting in the program. It could avoid any misreporting, double reporting, or incomplete reporting resulting from confusion over LCFS reporting responsibility among entities involved in the hydrogen supply chain.

### **Section 95483(b)(2). Contractually Designating First Fuel Reporting Entity and Credit or Deficit Generator for Gaseous Fuels**

#### Description of Problem

The entities qualifying as the first fuel reporting entity and credit generator for gaseous fuels and electricity in the LCFS are often small in size and report low quantities of fuel resulting in fewer LCFS credits. A small number of LCFS credits may not provide sufficient incentive for all entities to opt-in the program and comply with the reporting obligation and thus a qualified entity may not opt into the program.

### Proposed Solution

Staff is proposing to allow the first fuel reporting entity for gaseous fuels and electricity to contractually designate another entity to report fuel and generate credits in the LRT-CBTS.

### Rationale Supporting Proposed Solution

The proposed change will allow third-party entities to be able to aggregate, report and generate credits on behalf of entities that might have not opted into the program to avoid reporting obligation. This allows the program to capture the credits associated with fuel that would otherwise not have been reported if a qualified entity had chosen not to opt into the program.

## **Section 95483(c)(1). Residential EV Charging**

### Description of Problem

Since staff is proposing new incremental crediting methods for EV charging, additional eligibility requirements must be defined for entities responsible for the associated emission reductions.

### Proposed Solution

Staff is proposing changes to the existing eligibility requirements to reflect who is eligible to claim “base” credits for residential charging, and how is responsible for “incremental” credits from residential charging, or credits generated beyond what a grid-average carbon intensity might generate due to time-shifting charging behaviors or through procurement of low-CI electricity. In addition to the EDUs, who may continue to claim base credits for providing grid electricity to EVs, staff is proposing to allow any entities capable of providing charging records, such as automotive manufacturers, load serving entities, and charging station providers to be eligible to generate incremental credits.

Staff further proposes to relocate reporting requirements that are listed in this section in the current regulation; this allows section 95483 to focus solely on the entities eligible to report and generate credits. The reporting requirements remain detailed in section 95491; credit calculation details and additional requirements for claiming credits are provided in 95486.1, while requirements for fuel pathway applications been updated in 95488.5, 95488.7, and 95488.8.

### Rationale Supporting Proposed Solution

To facilitate actions to improve carbon intensity of electricity used for EV charging, revisions to electric vehicle credit generation and eligibility are required. Importantly, this section is used to establish who may claim incremental credits associated with shifting vehicle charging behaviors or for procuring lower carbon intensity electricity for residential charging. To prevent substantially restructuring the program, eligibility for base credits remains with the electricity distribution utilities (EDU). The revisions aim to build on top of the existing framework, to establish additional claims to “incremental” credits, reductions that are generated beyond what is already possible under the current

regulation. Entities eligible to claim these incremental credits can vary, as charging providers, automotive manufacturers, and load serving entities can all have a legitimate reason to claim incremental credits. As such, incremental credits may be claimed by entities capable of providing the necessary records to demonstrate that additional reductions have taken place. These records may then be used to calculate incremental credits.

### **Section 95483(c)(2). Non-Residential EV Charging**

#### Description of Problem

Under the current LCFS regulation, two types of non-residential charging are covered, EV fleet charging and private/workplace charging. They were originally included in the regulation separately to maximize the participations from different electricity stakeholders. The amount of credits, however, are determined by the vehicle types (light-, medium- and heavy-duty, etc.), and are the same for the two categories.

The current regulation limits entities eligible to generate credits from Public Access EV Charging, EV Fleet charging, and Private Access EV Charging. Other stakeholders that are capable and willing to generate credits from these categories cannot do so as they do not meet the definition of eligible entities.

#### Proposed Solution

To streamline the reporting, staff is proposing to combine the EV fleet charging and private access charging under a single category “Non-Residential EV Charging”.

Staff is also proposing to add flexibility by allowing any entity to be eligible to generate credits from Public Access Charging, and Private Access (including EV Fleet) Charging provided as long as it can fulfill all the reporting requirements and no other entity makes claim for the same credits.

#### Rationale Supporting Proposed Solution

Providing more flexibility to the eligible entities to generate credits for non-residential EV charging will enhance credit generators’ participation in this charging category. It should allow for broader participation from entities that are currently not opting in the program and thus could help capture credits from charging that is currently not claimed. The Fueling Supply Equipment (FSE) registration requirements will prevent any potential double claiming of the credits from the same charging equipment.

### **Section 95483(c)(4)(A). Electric Forklift**

#### Description of Problem

The California Sustainable Freight Action Plan<sup>50</sup> provides a vision for California’s transition to a more efficient, more economically competitive, and less polluting freight transport system. Electrification of the freight and goods movement system is a key

---

<sup>50</sup> State of California. California Sustainable Freight Action Plan. July 2016. Available at: [http://dot.ca.gov/hq/tpp/offices/ogm/cs\\_freight\\_action\\_plan/Documents/CSFAP\\_FINAL\\_07272016.pdf](http://dot.ca.gov/hq/tpp/offices/ogm/cs_freight_action_plan/Documents/CSFAP_FINAL_07272016.pdf)

element of such a transition. To more comprehensively incentivize this transition, the LCFS electricity provisions should more specifically cover a broader range of electric applications that use quantifiable electricity in freight and goods movement systems.

#### Proposed Solution

Staff proposes to expand the current Electric Forklift provision to include other mobile freight and goods movement equipment. The fleet operator would be the fuel reporting entity and the credit generator for electricity supplied to a specified fleet.

#### Rationale Supporting Proposed Solution

This change will allow these applications to receive the appropriate credit and build on the successful Electric Forklift reporting and crediting framework.

### **Section 95483(c)(5). Electric Transportation Refrigeration Units**

#### Description of Problem

The electricity provisions in the current regulation do not cover the full range of electric applications that use quantifiable electricity to replace conventional transportation fuel use. For example, Transport Refrigeration Units (TRUs) are refrigeration systems that are powered by internal combustion engines (ICE). They control the environment of temperature-sensitive products that are transported in refrigerated trucks, trailers, railcars and shipping containers. Certain TRUs have dual fuel capability. They could be powered by diesel-fueled internal combustion engines while moving, and powered by grid electricity whenever parked at electrified parking spaces. These type of units are known as Electric Transport Refrigeration Unit (eTRU).

#### Proposed Solution

Staff proposes to include eTRU as a separate category of electric transportation to generate credits under the LCFS.

#### Rationale Supporting Proposed Solution

This zero emission vehicle technology could increase the use of electricity as a fuel to displace gasoline or diesel and reduce GHG emissions, therefore, eTRUs should be recognized by the LCFS program. Allowing them to generate LCFS credits will send a signal to the market to expedite the penetration of such zero emission technologies.

### **SECTION 95483.1. OPT-IN ENTITIES.**

#### **Section 95483.1(a)(4). Natural Gas Supplier (deleted)**

#### Description of Problem

The current regulation allows a “natural gas supplier” to opt-in the LCFS program. This provision was focused on the suppliers of fossil CNG (Compressed Natural Gas).

#### Proposed Solution

Staff is proposing to remove the opt-in provisions for “natural gas supplier”.

### Rationale Supporting Proposed Solution

This provision is no longer required as staff is proposing, in section 95483(b)(2), allowing eligible fuel reporting entities to contractually designate third-parties to act on their behalf, as fuel reporting entity and credit generator, in the LCFS program.

### **Section 95483.1(a)(2). Project Operators**

#### Description of Problem

The purpose of this subsection is to designate the entity that is opting in to generate credits pursuant to the provisions of section 95489. However, the subsection does not provide a term to identify these entities.

#### Proposed Solution

Staff is proposing to refer to the entities that are opting in to generate credits pursuant to the provision of section 95489 as “Project Operators”.

#### Rationale Supporting Proposed Solution

This change will help in establishing clear responsibilities for entities opting in to generate credits pursuant to the provisions in section 95489.

### **Section 95483.1(a)(3). Clearing Service Provider**

#### Description of Problem

The current regulation allows regulated entities to make only over-the-counter credit transfers. That limit prevents parties from trading LCFS credits over exchanges, limiting the LCFS market participant’s ability to take advantage of the transparent futures and options markets offered by exchanges.

#### Proposed Solution

Staff is proposing to add eligibility requirements for clearing service providers for opting into program and providing clearing services to the regulated entities.

#### Rationale Supporting Proposed Solution

The proposed change will clearly establish eligibility requirements for a clearing services provider to opt in the program. Participation by clearing services providers will allow LCFS participants to engage in exchange-based trading of LCFS credits, which could add value to the program by helping create a transparent futures market. This could help in providing additional compliance flexibility, reduced investment risk in low-CI fuels, further standardized credit contracts, and better price discovery in the LCFS credit market.



## **Section 95483.1(b) and (c). Opting In and Out Procedure**

### Description of Problem

This section provides requirements for opting in and opting out of LCFS. However, opting in and opting out procedure provided in the current regulation can be clearer. Also, this section need an update to reflect the proposed changes in entity terminology as discussed in section 95481.

### Proposed Solution

Staff is proposing to clarify the opting in and opting out procedure for entities wishing to voluntarily opt in to the program, including clarification on the timeline of all the actions needed.

### Rationale Supporting Proposed Solution

The proposed change helps clarify rules and requirements for opting in and opting out procedure for the opt-in entities.

## **SECTION 95483.2. LCFS DATA MANAGEMENT SYSTEM.**

### **Section 95483.2. Restructuring and Strikeout**

### Description of Problem

The current section provides requirements for establishing and maintaining accounts in the LCFS Reporting Tool and Credit Banking and Transfer System. However, the section does not provide requirements for establishing an account in Alternative Fuels Portal. Further, the verification program may require another system component, which would need a clear regulatory framework.

### Proposed Solution

Staff is proposing to provide clear regulatory requirements for all the online systems, in the LCFS Data Management System, at one place in the regulation. The section is renamed and updated to provide clear regulatory requirements for all online systems responsible for LCFS data management and program implementation. The section provides specific requirements for each online systems that is a part of the LCFS Data Management System, including Alternative Fuels Portal (AFP); LCFS Reporting Tool and Credit Banking and Transfer System (LRT-CBTS); and the proposed LCFS Verification Portal (LVP).

Note that the entire section has been struck out in its original location and replaced with new proposed text.

### Rationale Supporting Proposed Solution

The proposed changes are focused on providing clear regulatory requirements for all the LCFS online systems while consolidating them at one place for the ease of finding them within the regulation. The updated structure of the section would make it easier for the users to understand and comply with the requirements.

## **Section 95483.2(b)(3)(G). Clearing Service Providers Accounts in LRT-CBTS**

### Description of Problem

The purpose of this section is to provide all the requirements for registering an account in LRT-CBTS. As staff is proposing to allow clearing service providers to participate in the program, LRT-CBTS account registration requirements for them also need to be provided here.

### Proposed Solution

Staff is proposing to provide requirements for clearing service providers to register an account in LRT-CBTS. Clearing service providers would be subject to all the requirements that other reporting entities are subject to and, in addition, they need to provide the documents demonstrating their eligibility pursuant to section 95483.1(a)(3).

### Rationale Supporting Proposed Solution

The proposed change will provide clear requirements for clearing service providers to register an account in LRT-CBTS, and make any such parties subject to California court jurisdiction.

## **Section 95483.2(b)(8). Registration of Fueling Supply Equipment**

### Description of Problem

In the first quarter of 2017, the LRT-CBTS was updated with a new module to support Fueling Supply Equipment (FSE) registration for gaseous fuels and electricity. The current regulation does not provide requirements for FSE registrations.

### Proposed Solution

Staff is proposing to provide clear requirements for FSE registration for gaseous fuels, electricity, and propane in the LRT-CBTS.

### Rationale Supporting Proposed Solution

The proposed changes incorporate the current reporting practices in the regulation. The FSE registration requirements are intended to improve the quality of reported data and help prevent potential double counting of fuel quantities dispensed in California.

## **Section 95483.2(c). LCFS Verification Portal (LVP)**

### Description of Problem

Staff is proposing to add third-party verification requirements in the program and for its implementation the existing LCFS data management system needs to be updated. As detailed in sections 95500 through 95503, third-party verifiers would require access to relevant data submitted through the AFP and LRT-CBTS and would also need the ability to communicate and securely share necessary information with the regulated entities and CARB.

### Proposed Solution

Staff is planning to create a new “LCFS Verification Portal” (LVP) to support the implementation of third-party verification in LCFS, and proposes to provide requirements for registration and management of an account in LVP.

### Rationale Supporting Proposed Solution

The proposed change will provide clear requirements for entities providing verification services to register and manage an account in the LVP, which will be a part of the LCFS data management system.

## **Section 95483.3. Change of Ownership**

### Description of Problem

The current regulation does not provide any rules and requirements to be followed in case of bankruptcy or ownership changes for an organization or a facility registered in the LRT-CBTS, the AFP, or the LVP.

### Proposed Solution

Staff is proposing to create a new section to provide rules governing bankruptcy or ownership changes for an organization or a facility registered in the LRT-CBTS, the AFP, or the new Verification Portal.

### Rationale Supporting Proposed Solution

The proposed change provides clarity to the existing and the new owner about the LCFS requirements, in case of bankruptcy or change of ownership for an organization or a facility registered in the LRT-CBTS, the AFP, or the new Verification Portal. This will ensure there is always clarity on which entity has liability for any deficits in the program when an account is closing, and ensures environmental integrity in the system.

## **SECTION 95484. ANNUAL CARBON INTENSITY BENCHMARKS**

### **Section 95484(a) through (g). Requirement to use Carbon Intensity Benchmarks**

### Description of Problem

The LCFS regulation achieves a carbon intensity reduction target by setting a standard or “benchmark” for each year, which is used in credit and deficit calculations such that the average carbon intensity of the transportation fuel pool is reduced by the targeted amount, provided that all deficit generators meet their obligation to obtain and retire sufficient credits to cancel their deficits. Section 95484(a) states that “a regulated party must meet the average carbon intensity requirements...” which could be improved to more clearly describe the requirements for a regulated party who is a credit generator. The carbon intensity values in Tables 1 and 2 are used in calculating both credits and deficits, but the term “compliance” may be misinterpreted to imply that such values are

only applicable to deficit generators, whose fuels have CI values higher than the standard.

#### Proposed Solution

The term “benchmark” or phrase “annual carbon intensity benchmarks” are now used in place of “carbon intensity requirement” or “compliance schedule,” to add clarity without changing any of the mechanics of the credit and deficit calculations. Similarly, the text in subsection (a) is revised to instruct that the values in Tables 1, 2, and 3 are used in “credit and deficit calculations, as described in section 95486,” rather than “a regulated party must meet the average carbon intensity requirements.” This change is intended to more precisely describe the regulation’s requirements and calculation methodology. For consistency, similar terms are substituted in subsections (e), (f), and (g).

#### Rationale Supporting Proposed Solution

The introduction of the term “benchmark” and the phrase “annual carbon intensity benchmarks” does not have a material impact on the requirements of the regulation, but is intended to avoid confusion.

### **Section 95484(b) through (c)**

#### Description of Problem

The current LCFS targets a 10 percent reduction in average fuel carbon intensity by 2020 and maintains that target for all subsequent years. Nevertheless, the production and use of fossil transportation fuels—most of which have a high carbon intensity—continues to contribute significantly to global warming. Strengthening the carbon intensity reduction targets of the LCFS regulation through 2030 is one of the primary objectives of this rulemaking and is discussed extensively in Chapter II of this Staff Report.

#### Proposed Solution

Staff is proposing carbon intensity benchmarks shown in Tables 1 and 2 in proposed section 95484 for the years 2019 to 2030 and subsequent years. The benchmarks chosen constitute a series of decreases in future years, as compared to conventional fuels and compared to the present regulation. The proposed benchmarks will incentivize even lower carbon intensity fuels and vehicle technologies, allowing for further GHG reductions.

#### Rationale Supporting Proposed Solution

Staff conducted an in-depth analysis of possible scenarios that informed possible benchmarks through 2030 (see Chapter VIII of this Staff Report for details). Staff developed several modeling tools that take into account feedstock supply, fuel prices, fuel incentives, and capacity constraints to assess the technical and economic feasibility of bringing low carbon fuels to California. This analysis accounted for the potential effects of additional proposed changes to the LCFS, such as the addition of alternative jet fuels, crediting for carbon capture and sequestration (CCS), and revisions to the

refinery credit provisions, which may affect the volumes and types of fuels used to comply with the standard.

### **Section 95484(d). Benchmarks for Fuels used as a Substitute for Conventional Jet Fuel**

#### Description of Problem

Since staff is proposing to allow alternative jet fuel to generate credits under the LCFS, therefore, annual carbon intensity benchmarks specifically for calculating credit from alternative jet fuel must be set.

#### Proposed Solution

Staff is proposing the carbon intensity benchmarks shown in Table 3 in proposed section 95484 for alternative jet fuel. The benchmarks chosen constitute a series of decreases compared to conventional jet fuel.

The annual carbon intensity benchmarks are anchored to a 2010 baseline CI for conventional jet fuel and incorporate the same annual percent reduction as the benchmarks for gasoline and diesel for years 2019 through 2030. The 2010 baseline CI for conventional jet fuel was determined using the updated CA-GREET 3.0 model. Alternative jet fuel will generate credits based on the difference between the alternative jet fuel pathway's CI and that of the jet fuel carbon intensity benchmark for the year in question.

#### Rationale Supporting Proposed Solution

To maintain consistency with the annual carbon intensity benchmark for diesel and gasoline and to create a level playing field with ground transportation fuels, staff is proposing that the annual carbon intensity benchmarks for alternative jet fuel incorporate the same annual percent reduction as the annual carbon intensity benchmarks for gasoline and diesel for 2019 through 2030.

### **Section 95484(e) and (f). Carbon Intensity Benchmarks**

#### Description of Problem

The current regulation provides instructions for calculating credits and deficits using phrasing which implies that a fuel reporting entity must select the appropriate benchmark value (i.e. the CI standard for a given year). In actuality, the calculations are automated in the LRT-CBTS, and the appropriate benchmark value is provided by the Executive Officer.

This section is also proposed to be updated to reflect the proposed changes in entity terminology; please see the problem, solution and rationale for section 95481(a), "Definitions pertaining to Classification of LCFS Participants" for more information relating to those proposed changes.

### Proposed Solution

Staff proposes to rephrase the instructions to clarify that the Executive Officer assigns the correct benchmark, and the fuel reporting entity does not need to perform the calculation.

### Rationale Supporting Proposed Solution

The proposed change helps clarify the process for calculating credits and deficits.

## **Section 95484(g)(2). Instructions for Alternative Fuels used in a Multi-fueled Vehicle**

### Description of Problem

The current regulation provides instructions for calculating credits and deficits for alternative fuels used in multi-fuel or bi-fuel vehicles, when none of the fuels are gasoline or diesel. Staff is not aware of any vehicles to which this provision would apply.

### Proposed Solution

Staff proposes to strike section 95484(g)(2).

### Rationale Supporting Proposed Solution

Staff is seeking to reduce the length of the regulation to improve clarity and readability by removing unused provisions.

## **SECTION 95485. DEMONSTRATING COMPLIANCE.**

### **Section 95485(a)(2). Mandatory Retirement of Credits for the Purpose of Compliance**

### Description of Problem

This section provides rules for mandatory retirement of credits for compliance demonstration. In the current regulation, the regulated entity is required to retire the credits at the time of Annual Compliance Report submission. However, in practice, LRT-CBTS calculates and retire credits necessary for compliance demonstration at the time of Annual Compliance Report submission. These requirements are provided under section 95487 in the current regulation.

### Proposed Solution

Staff is proposing to update the requirements to reflect the automatic credit retirement process by LRT-CBTS and move the requirements to section 95485.

### Rationale Supporting Proposed Solution

The proposed changes reflect the current reporting practices in the LRT-CBTS. The requirements are more appropriate to include in section 95485, which provides rules related compliance demonstration, rather than in section 95487, which provides rules related to credit transactions.

## **Section 95485(b)(2). Calculation of Credit Balance**

### Description of Problem

The subsection provides an equation to calculate an entity's credit balance in the LRT-CBTS account at the end of compliance period. The equation accounts for the credits exported out of the program. However, the provision that allows for the export of LCFS credits from LRT-CBTS to another program has never been used. Further, the equation does not include the credits released from administrative hold, credits pledged for sale in the clearance market, and credits adjusted or invalidated due to administrative or enforcement action that must be accounted for determining the credit balance in the LRT-CBTS.

### Proposed Solution

Staff is proposing to update the credit balance equation to remove the exported credits and to include the credits released from administrative hold, credits pledged for sale in the clearance market and withheld from the ongoing LCFS market, and credits adjusted or invalidated due to administrative or enforcement action.

### Rationale Supporting Proposed Solution

The proposed changes reflect proper accounting methodology necessary for calculating credit balance in the LRT-CBTS.

## **Section 95485(c)(1)(A). Definition of Ongoing LCFS Credit Market (Deleted)**

### Description of Problem

The current regulation provides a definition of Ongoing LCFS Credit Market, which staff considers to be self-explanatory.

### Proposed Solution

Staff is proposing to remove the definition of Ongoing LCFS Credit Market.

### Rationale Supporting Proposed Solution

The current regulation is sufficiently clear when it refers to the LCFS Credit Market as distinct from the Credit Clearance Market. Staff is seeking to reduce the length of the regulation to improve clarity and readability by removing unused provisions.

## **Section 95485(c)(1)(A). Compliance Requirement If Credit Clearance Market Occurs**

### Description of Problem

This section provides the compliance requirements for an entity that failed to demonstrate compliance obligation pursuant to section 95485(a) given credit clearance market occurs for that compliance period. One of the requirement is to retire all credits in an entity's account before it can be in compliance but it is not included under this section and is provided in section 95485(c)(2)(A) in the current regulation.

### Proposed Solution

Staff is proposing to clarify the requirements for an entity to be in compliance if credit clearance market occurs and include the requirement to retire all credits in the entity's account.

### Rationale Supporting Proposed Solution

This change will clarify the requirements for entity to be in compliance if it was unable to demonstrate compliance pursuant to section 95485(a).

## **Section 95485(c)(2)(C). Applicability of Credit Clearance Market Rules**

### Description of Problem

This section provides conditions for entity to qualify for compliance via Credit Clearance Market. With the proposed changes in section 95485(c)(1)(A), these requirements are duplicative.

### Proposed Solution

Staff is proposing to remove the subsection as the requirements are covered under other sections of proposed the regulation.

### Rationale Supporting Proposed Solution

The change provides credit clearance related requirements in a single location and avoids redundancy.

## **Section 95485(c)(3)(C). Maximum Price for Credits in the Clearance Market**

### Description of Problem

The section provides the methodology for the calculation of the maximum price for credits in the clearance market. The methodology suggests a fixed price for the year 2016 and requires it to be adjusted annually based on the rate of inflation as measured by the most recently available twelve months of the Consumer Price Index for All Urban Consumers. However, the references to the CPI were not consistent.

### Proposed Solution

Staff is proposing to update this subsection to provide clear reference to the relevant Consumer Price Index and further clarity on the methodology for the calculation of the maximum price for credits in the clearance market.

### Rationale Supporting Proposed Solution

The proposed change will avoid any confusion in determining the maximum credit price for credits in the clearance market for a given year.



## **Section 95485(c)(5)(A). Compound Interest on Accumulated Deficits**

### Description of Problem

The current regulation requires the Executive Officer to apply 5 percent interest on Accumulated Deficits in an entity's account, annually. However, timing for calculating and applying this interest could be clarified.

### Proposed Solution

Staff is proposing the 5percent interest be applied on each September 1<sup>st</sup> for any Accumulated Deficits in an entity's account from previous compliance year.

### Rationale Supporting Proposed Solution

This change will allow entities to retire credits acquired during CCM to meet the remaining compliance from prior compliance years and submit a final Annual Compliance Report by August 31<sup>st</sup>. Any deficits from prior compliance remaining in the entity's account upon final Annual Compliance Report submission will charged a 5 percent interest on each September 1<sup>st</sup>.

## **Section 95485(d). Limitations on the Use of Refinery Investment Credits and Renewable Hydrogen Refinery Credits (Deleted)**

### Description of Problem

The current regulation puts limits on the use of credits generated pursuant to the Refinery Investment Credit Pilot Program and the Renewable Hydrogen Refinery Credit Pilot Program. For innovative projects such as carbon capture and sequestration and renewable hydrogen, these restrictions could undermine potential investment incentives and thereby fail to provide significant potential GHG reductions.

### Proposed Solution

Staff is proposing to remove the 20% of annual compliance obligation limit on the use of refinery investment credits if credits are generated from innovative projects such as carbon capture and sequestration and renewable natural gas use, and to remove the 10% of annual compliance obligation limit on the use of renewable hydrogen refinery credits. However, staff is proposing a 5% limit on process improvement projects that do not fall in the list of innovative projects in section 95489(e)(1)(E) from 1. through 4. Because that 5% limit is described separately in 95489(e)(1)(H) of the proposed amendments, staff proposes deleting section 95485(d) as no longer necessary.

### Rationale Supporting Proposed Solution

This change will remove limiting restrictions on refiners' ability to generate and trade credits from innovative refinery investment projects and renewable hydrogen projects. These projects have significant potential to reduce the carbon intensities of CARBOB and diesel by introducing transformative technologies thereby contributing to the goals of the LCFS. The removal of these restrictions is designed to further encourage investments in innovative projects.

## **SECTION 95486. GENERATING AND CALCULATING CREDITS AND DEFICITS.**

### **Section 95486. Restructuring**

#### Description of Problem

This section provides rules and requirements for calculating and generating credits and deficits in the program. Staff seeks to provide a clear distinction among the rules and requirements for different credit and deficit generation provisions in the regulation.

#### Proposed Solution

Staff is proposing to update section 95486 to include only the general rules and requirements for calculating and generating credits and deficits that applies to all types of credit and deficit generation in the program. Staff is proposing to create a new section 95486.1 to provide rules and requirements for calculating and generating credits and deficits based on fuel pathways. Rules and requirements for calculating and generating credits for project based crediting provisions will be provided in section 95489.

#### Rationale Supporting Proposed Solution

This change will clarify the general rules and requirements for all credit and deficit generators irrespective if the credits and deficits are generated based on fuel pathway crediting or project based crediting provisions.

### **Section 95486(a)(1). Credit and Deficit Issuance**

#### Description of Problem

This section provides rules governing issuance of credits and deficits in the LRT-CBTS. In the current regulation, some of the general requirements that an entity must meet for issuance of credits and deficits were not included in this section and are provided in other parts of the regulation.

#### Proposed Solution

Staff is proposing to provide all the general requirements that an entity must meet for issuance of credits and deficits.

#### Rationale Supporting Proposed Solution

The proposed change helps clarify the requirements for an entity to be issued credits and deficits in their account.

### **Section 95486(a)(2). Prohibition of Retroactive Credit Claim**

#### Description of Problem

The regulation prohibits an entity from retroactively claiming credits for a period for which the reporting deadline has passed. Similarly, an entity cannot eliminate deficits retroactively for a period for which the reporting deadline has passed. However, the provision in the current regulation could further clarified. Additionally, the current

regulation also provides an exemption from this provision to credits on hold resulting from incomplete fuel transport demonstration pursuant to section 95488(d) and (e) and application completion pursuant to section 95489. Some of these provisions are being removed in the proposed regulation.

#### Proposed Solution

Staff is proposing to clarify the prohibition of retroactive credit claim or deficit elimination. Since staff is also proposing changes in the sections 95488 and 95489 that will not allow for retroactive generation of credits, the exemption provided to provisional credits is no longer needed and will be removed.

#### Rationale Supporting Proposed Solution

The proposed changes will clarify and simplify the existing prohibition.

### **Section 95486(a)(3). Buffer Account**

#### Description of Problem

In situations where the Executive Officer determines LCFS credits to be invalid, CARB will seek to invalidate an equivalent amount of credits from the account of the initial credit generator. If CARB cannot recover such credits from the initial credit generator, for any reason, the Executive Officer retains the flexibility to invalidate the credits held by an entity other than the initial credit generator at the time of discovery. This “buyer liability” policy is important to ensure the environmental integrity of the program. However, staff also recognizes that this policy may pose a concern for the credit buyers, and result in reduced credit liquidity as a buyer must evaluate the likelihood of each credit generator being able to cover any invalid credits on a firm-by-firm basis. That impedes the goal of facilitating the lowest cost of compliance, which is the purpose of the credit market.

Further, the proposed changes would allow exchange trading of LCFS credits to further liquidity in the credit market and promote a robust and transparent futures market that regulated parties could use to finance longer-term investments in low carbon fuels. Exchange trading is unlikely to develop if buyers view different credits as having dramatically different invalidation risks.

As a specific example of where invalidation might occur, Carbon Capture and Sequestration (CCS) projects are a new proposed way to generate credits in the program; in the event of a leakage or reversal, the Executive Officer would need to invalidate credits, either from the Project Operator’s account or from the account from a downstream party that had purchased credits from the project.

Separately, in some instances, there are real emission reductions that may not be validly claimed by any entity pursuant to reporting requirements in the LCFS rule (for example, the prohibition on retroactive credit generation). There could also be stranded credits in a LRT-CBTS account that is no longer active. These credits represent real

emission reductions and could be accounted for in the GHG benefits provided by the program.

#### Proposed Solution

To resolve all the problems discussed above, staff is proposing creation of a buffer account for LCFS credits. Staff is suggesting, in the event of credit invalidation, that if the person responsible for the credits' invalidity no longer exists, or is otherwise unavailable to reimburse the program, then the Executive Officer may retire credits from the buffer account to make the LCFS program whole and ensure environmental integrity.

Staff proposes that the buffer account be populated by credits from several sources: (1) Real GHG emission reductions that may not be validly claimed by any entity pursuant to section 95486(a)(2); (2) Real GHG emission reductions representing the difference between the reported CI and the verified operational CI from annual Fuel Pathway Reports for each fuel pathway code; (3) credits from CCS projects determined using the project risk rating framework provided in the CCS Protocol; and (4) Any credits remaining in a deactivated LRT-CBTS account.

#### Rationale Supporting Proposed Solution

The creation of buffer account could help mitigate the invalidation risk for credit buyers and safeguard the environmental integrity of the program following some credit invalidations. Moreover, the buffer account will also provide an option to recognize and account for real GHG emission reductions that are not being accounted for in the current rule.

### **Section 95486(b)(2). Table 4: Energy Densities and Conversion Factors for LCFS Fuels and Blendstocks (Formerly Table 3)**

#### Description of Problem

The table provides energy density values of LCFS fuels and blendstocks to be used for calculation of credits and deficits. The table needs to be updated for consistency with staff's proposals to include Alternative Jet Fuel and Propane in the program and to change reporting requirements for natural gas.

#### Proposed Solution

Staff proposes to add energy density values for Alternative Jet Fuel and Propane.

Staff proposes to provide the energy density value for CNG in therms per megajoule (MJ) and remove the energy density values for Pure Methane and Natural Gas in cubic feet per MJ.

Staff is updating the title of the table to reflect the changes.

### Rationale Supporting Proposed Solution

Energy density values for Alternative Jet Fuel and Propane need to be added as they will be required for calculating credits and deficits for reported fuel quantities.

Energy density values are used to calculate total amount of fossil fuel energy displaced by the alternative fuel based on the quantity of the fuel reported. Since staff is proposing to change the reporting units for CNG and L-CNG from volumetric units (cubic feet) to energy units (therms), the conversion from volume to energy will no longer be required. Thus, energy density values provided for natural gas in the current regulation will no longer be required. Pure methane is not reported in the LRT-CBTS and, therefore, the energy density value for pure methane is not required.

### **Section 95486(b)(2). Equation for Calculating the Total Credits**

#### Description of Problem

This subsection provides equations for calculating the total credits and deficits generated by an entity in a compliance period. The existing equation for calculating total credits generated does not include the credits generated for reporting alternative jet fuels or credits generated from opt-in projects.

#### Proposed Solution

Staff is proposing to update the equation for calculating the total credits generated to clearly reflect the credits that could be generated from alternative jet fuels and opt-in projects.

#### Rationale Supporting Proposed Solution

The proposed changes will provide equations for accurately accounting total credits generated across all possible sources of credits.

### **SECTION 95486.1. GENERATING AND CALCULATING CREDITS AND DEFICITS USING FUEL PATHWAYS.**

*(see the problem, solution, and rationale for section 95486 restructuring)*

#### **Section 95486.1(a)(1). General Calculation of Credits and Deficits Using Fuel Pathways**

#### Description of Problem

Staff is proposing to allow alternative jet fuel to generate credits under the LCFS. However, under the current regulation, the equation for generating credits or deficits does not explicitly include the average carbon intensity requirement for jet fuel.

#### Proposed Solution

Staff is proposing to explicitly include jet fuel when listing the average carbon intensity requirements for  $CI_{standard}^{XD}$ .

### Rationale Supporting Proposed Solution

This change will ensure that the average carbon intensity requirement for jet fuel is included when determining the credits or deficits generated by a fuel reporting entity.

### **Section 95486.1(a)(4). Credit Calculation Equation for Fixed Guideway Systems and Forklifts**

#### Description of Problem

Under the current regulation, the equation for new fixed guideway systems or expansions post-2010 includes an EER adjustment. This provides more accurate incentives for fixed guideway systems that were brought on line after the implementation of LCFS rule. But the current credit calculation for forklifts does not account for an EER adjustment.

#### Proposed Solution

Staff is proposing to provide the EER adjustment for electric and hydrogen fuel cell forklifts with a model year 2010 or later.

### Rationale Supporting Proposed Solution

This change will ensure credit calculations are consistent among all the off-road applications i.e. Fixed Guideway Systems and Forklifts.

### **Section 95486.1(a). Table 5: EER Values for Fuels Used in Light- and Medium-Duty, and Heavy-Duty Applications (Formerly Table 4)**

#### Description of Problem

The Energy Economy Ratio (EER) values represent the differences in efficiency between conventional fuel vehicles and the alternative fuel vehicles that replace them. As this ratio can change over time updates will occasionally be needed. For example, during the initial LCFS rulemaking, staff established an EER of 2.7 for battery electric trucks compared to diesel trucks based on limited data. In the 2015 LCFS Re-adoption, the EER for EV buses was set at 4.2 based on updated test data. As more advanced zero emission trucks and buses have come to market, and staff has continued to gather information about the efficiency of these vehicles, it is time to conduct an EER update in these categories.

Further, some vehicle types are not well represented in the current rule. For example, the EER value for eTRU and e-motorcycles have not previously existed as separate values in the LCFS regulation.

Since staff is proposing to include alternative jet fuels and propane under the regulation, EER for these applications also need to be included.

### Proposed Solution

Staff is proposing to add to Table 5 EER values of 3.4 for eTRU, 4.4 for on-road e-motorcycle, 1.0 for jet fuels, 1.0 for propane used in light- and medium-duty vehicle applications, and 0.9 for propane used in heavy-duty vehicle applications.

Staff is proposing to update the EER values for heavy-duty electric vehicles to 5.0.

### Rationale Supporting Proposed Solution

The data, studies and calculations that staff relied upon in determining the proposed EER values are documented in detail in Appendix H of this Staff Report.

The EER of 2.7 for heavy-duty electric trucks in the current LCFS regulation was based on the EER in a February 2007 report to the California Energy Commission (CEC).<sup>51</sup> During the 2015 LCFS Re-adoption, staff included an EER value of 4.2 for electric buses, based on Altoona Bus Test.<sup>52</sup> A recently published report by CARB staff<sup>53</sup> relies primarily on improved studies performed with comparable vehicles and loads on the same test cycles, which support the modification of the EER value for heavy-duty electric vehicles.

The estimated EER for eTRU based on a preliminary study<sup>54</sup> is relatively conservative, because the energy consumption in a multi-temperature TRU, which is used in the study, is typically greater due to separate temperature zones and more frequent door openings inherent with multi-temperature applications. A typical energy consumption in a single temperature TRU may be closer to 9 kWh/h which would result in a higher EER value. It is expected that ongoing studies by CARB and other organizations will contribute more data to refine the EER value(s) for eTRUs.

The proposed EER value for on-road e-motorcycle is conservative, as it is based on a preliminary study<sup>55</sup> of electric on-road and dual sport motorcycles' miles per gasoline gallon equivalent data generated using the Urban Dynamometer Driving Schedule (UDDS), which may not accurately reflect real-world driving conditions. Staff will evaluate additional data as it becomes available, and will consider proposing to amend

---

<sup>51</sup> Full Fuel Cycle Assessment: Tank to Wheels Emissions and Energy Consumption. Available at: <http://www.energy.ca.gov/2007publications/CEC-600-2007-003/CEC-600-2007-003-D.PDF>

<sup>52</sup> Calculation of Proposed Energy Economy Ratio Under the Low Carbon Fuel Standard Regulation. CARB, November 2014. Available at: [https://www.arb.ca.gov/fuels/lcfs/lcfs\\_meetings/111314bus\\_eer\\_for\\_workshop.pdf](https://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/111314bus_eer_for_workshop.pdf)

<sup>53</sup> Battery Electric Truck and Bus Energy Efficiency Compared to Conventional Diesel Vehicles. CARB, September 2017. Available at: <https://www.arb.ca.gov/msprog/actruck/docs/HDBEVefficiency.pdf>

<sup>54</sup> Calculation of Proposed Energy Economy Ratio (EER) for Electric Transport Refrigeration Units (eTRU) under the Low Carbon Fuel Standard. CARB, September 2017. Available at: [http://www.cleanfuture.us/wp-content/uploads/2017/09/EER-for-eTRU-for-CARB-LCFS-Workshop\\_proposed-by-CleanFuture.pdf](http://www.cleanfuture.us/wp-content/uploads/2017/09/EER-for-eTRU-for-CARB-LCFS-Workshop_proposed-by-CleanFuture.pdf)

<sup>55</sup> Estimate for Energy Economy Ratios for Consideration of On-Road and Off-Road Motorcycles in the Low Carbon Fuels Standard Program. CARB, October 2017. Available at: [https://www.arb.ca.gov/msprog/offroad/orrec/zem\\_eer\\_calcs\\_10\\_9\\_17.pdf](https://www.arb.ca.gov/msprog/offroad/orrec/zem_eer_calcs_10_9_17.pdf)

to the on-road motorcycle EER, and including off-road applications, if such action is supported by a more robust data set than currently available.

The proposed EER values for propane relative to conventional diesel and gasoline vehicles are based on test data from the Altoona Bus Research and Testing Center, and a comparison of the efficiency of propane relative to natural gas.

For additional information on the proposed EERs, please see Appendix H.

### **Section 95486.1(b). Credit and Deficit Generation Frequency Using Fuel Pathways**

#### Description of Problem

This subsection discusses the frequency at which credits may be generated in the LCFS program. Currently, the credits are generated and issued instantly in an LRT-CBTS account upon submittal of a quarterly report. However, the current regulation also requires that reporting entities shall reconcile their fuel data before submitting reports for credits generation.

#### Proposed Solution

Staff is proposing to update LRT-CBTS to reflect the requirements in the regulation so that credits or deficits will be issued in the system only for the liquid fuel data that is reconciled among the business partners.

To implement the change, staff is proposing to clearly define a date for issuance of credits and deficits for all fuel types upon completion of the reporting deadline. This will allow LRT-CBTS to check all the reports for completeness and reconciliation before credits are issued by the Executive Officer.

#### Rationale Supporting Proposed Solution

The proposed change will eliminate the need for third-party verification of fuel transactions reported downstream of the producer or importer for liquid fuels while ensuring the highest quality and integrity of the LCFS credits. These changes will also enable CARB to limit the scope of the third-party verification to transactions types including production, import, and export for liquid fuels.

### **Section 95486.1(c). Calculation of Credits for Residential EV Charging Using Fuel Pathways**

#### Description of Problem

Since staff is proposing a new framework for recognizing residential electric vehicle charging that uses low-CI electricity pathways, provisions are needed to allow for calculating base and incremental credits.



### Proposed Solution

Staff is proposing to update section 95486.1 to include detailed methods for credit generation for “low-CI” electricity (below the average grid CI) pathways.

Base and incremental credits are being proposed such that electric utilities would be able to claim credit for residential EV charging using the California average grid CI. If the EDU or another entity contracts low-CI electricity sources, beyond what is required for compliance with the California Renewables Portfolio Standard (RPS), then that entity would be eligible to claim credits reduction below the grid CI.

Charging that coincides with periods of consistent solar or wind energy curtailment would also be eligible for receiving additional credits using Time-of-Use pathways, as charging during these times is likely to use otherwise unutilized zero-CI electricity.

### Rationale Supporting Proposed Solution

In the current regulation, improvements in the feedstocks and energy sources used in the fuel pathway are recognized to reduce CI. Low-CI electricity that is supplied to electric vehicles sources should similarly be recognized.

Additionally, at certain periods in the day, electricity demand and energy storage are not sufficient to use all electricity that could be generated from zero-carbon electricity sources such as wind and solar. This results in curtailment of these electricity sources. If electric vehicle charging coincides with periods of curtailment, then additional zero-carbon electricity is dispensed, and higher carbon electricity that might otherwise be used is directly displaced. The LCFS can help incentivize behaviors that better integrate contracted renewable electricity with consistent grid-usage patterns.

## **Section 95486.1(d). Calculation of Credits for Non-Residential EV Charging Using Fuel Pathways**

### Description of Problem

Since staff is proposing to recognize electric vehicle charging that uses low-CI electricity pathways, provisions are needed to allow for calculating credits.

### Proposed Solution

Staff is proposing to update section 95486.1 to include detailed methods for credit generation for low-CI electricity pathways. These changes would include credit calculation provisions for low-CI electricity used for non-residential EV charging, and inclusion of credit calculation methodologies for EV charging during periods of wind and solar electricity curtailment.

### Rationale Supporting Proposed Solution

Please see the rationale for section 95486.1(c). Because non-residential charging is different from residential charging, and different entities are responsible for providing access to charging stations, clarification is necessary for reducing carbon intensity through the use of low-CI electricity pathways for non-residential applications.

## **Section 95486.1(e). Calculation of Credits for Hydrogen Using Fuel Pathways**

### Description of Problem

Since staff is proposing to recognize hydrogen pathways that use low-CI electricity, provisions are needed to allow for calculating credits.

### Proposed Solution

Staff is proposing to update section 95486.1 to include detailed methods for credit generation for low-CI electricity pathways. These changes would include credit calculation provisions for low-CI electricity used for producing electrolytic hydrogen, and inclusion of credit calculation methodologies for electrolytic hydrogen production during periods of wind and solar electricity curtailment.

### Rationale Supporting Proposed Solution

Please see the rationale for section 95486.1(c) and (d).

## **SECTION 95487. CREDIT TRANSACTIONS.**

### **Section 95487(a)(1)(C). Export of LCFS Credit to Other Programs**

#### Description of Problem

The subsection allows an entity to export LCFS credits to other GHG emission reduction programs established pursuant to AB 32. However, there is no existing program that allows for the import of LCFS credits from LRT-CBTS.

#### Proposed Solution

Staff is proposing to remove the provision for exporting LCFS credits to other programs.

#### Rationale Supporting Proposed Solution

The proposed change removes a provision that is not applicable as there is no program that allows for the import of LCFS credits from LRT-CBTS. Staff is seeking to reduce the length of the regulation to improve clarity and readability by removing unused provisions.

### **Section 95487(b)(1). Mandatory Retirement of Credits for the Purpose of Compliance (Moved)**

#### Description of Problem

Section 95487 provides rules and requirements related to credit transactions in the LRT-CBTS. The rules for mandatory retirements of credits for the purpose of compliance are not related to credit transactions.

### Proposed Solution

Staff is proposing to move the requirements under section 95485 which provide rules and requirements related to compliance demonstration.

### Rationale Supporting Proposed Solution

This change will provide all compliance related rules and requirements under a single section.

## **Section 95487(b)(2). Credit Retirement Hierarchy (Deleted)**

### Description of Problem

The subsection provides a default hierarchy for retiring credits in the LRT-CBTS for compliance demonstration. It has proven difficult to program the LRT-CBTS to follow the provided default credit retirement hierarchy.

### Proposed Solution

Staff is proposing to remove the default credit retirement hierarchy.

### Rationale Supporting Proposed Solution

The provision was added in the regulation to prospectively update the LRT-CBTS to create a default hierarchy. However, the hierarchy for retiring credits depends on part on assigning vintage years to credits. Staff believes that effort would be unduly complicated with little benefit. It will be simpler to eliminate the hierarchy.

## **Section 95487(c)(1)(A). Credits Pledged for Sale in Clearance Market**

### Description of Problem

The subsection provides an equation to calculate the total number of credits available in an entity's account to transfer to another account. The equation does not include the credits pledged for sale in the clearance market.

### Proposed Solution

Staff is proposing to update the equation to include the credits pledged for sale in the clearance market.

### Rationale Supporting Proposed Solution

The proposed changes reflect the proper method for calculating credit available for transfer in an LRT-CBTS account.

## **Section 95487(c)(1)(B). Spot and Forward Credit Transfers**

### Description of Problem

After reviewing the historical record of credit transfers reported in the LRT-CBTS, staff discovered instances of credit transfers with reported prices that deviated significantly from the prices of other concurrently reported transactions. After investigation, staff found that, generally, the credit transfers with anomalous prices were part of credit

agreements that parties finalized long before the date of credit transfer (forward deals). Further, as staff is proposing to allow clearing service providers to participate in the program, there could be credits transferred for a contract arranged through an exchange or clearing service provider (including forward deals with terms standardized by the exchange, sometimes called futures). As CARB uses the reported information for publishing its weekly and monthly LCFS credit activity reports, staff would like to identify any transfers that do not represent the current spot market conditions. However, in the current regulation, an entity is not required to identify whether the proposed credit transfer is part of a long-term agreement.

#### Proposed Solution

Staff is proposing to provide, on the credit transfer form, the ability to identify three categories for proposed credit transfers. First, if the credit transfer is based on an agreement that includes only a single delivery of credits within 10 days from the date of agreement. Second, if the credit transfer is based on an agreement that includes multiple credit deliveries or if at least one delivery takes place more than 10 days from the date of the agreement. Third, if the credit transfer is based on a contract arranged through an exchange.

#### Rationale Supporting Proposed Solution

This change will allow CARB to identify and record information about credit transfers including the date and the price at which the agreement was settled. Based on that information, CARB can identify and publish more relevant information related to the credit transfers.

### **Section 95487(c)(1)(C) and (D). Timing for Initiating and Completing a Credit Transfer**

#### Description of Problem

The current regulation requires the Seller to report the credit transfer in the LRT-CBTS within 10 days from the date of credit transaction agreement, and the Buyer is required to complete an incoming transfer in LRT-CBTS within 10 days of receiving it. As CARB uses the reported information for publishing its weekly and monthly LCFS credit activity reports, some credit transfers are reported late.

#### Proposed Solution

Staff is proposing to require the Seller to report the credit transfer in the LRT-CBTS within five days from the date of credit transaction agreement and the Buyer to complete an incoming transfer in LRT-CBTS within five days of receiving it.

#### Rationale Supporting Proposed Solution

This change will allow credit transfers to be reported more timely in LRT-CBTS and enable CARB to publish more up-to-date information related to the credit transfers.

## **Section 95487(c)(1)(C)(7). Zero Dollar Price Credit Transfers**

### Description of Problem

After reviewing credit transfers reported in the LRT-CBTS, staff also discovered that some credit transfers are reported with a zero-dollar price. After investigation, it was found that these zero-dollar credit price transfers were result of credit agreements or situations in which an absolute price or methodology to calculate an absolute price is unavailable. As CARB uses the reported information for publishing its weekly and monthly credit activity reports, it is important to identify zero-dollar price transfers separately. However, there is no requirement for an entity to provide an explanation when proposing or accepting a transfer with zero-dollar credit price.

### Proposed Solution

Staff is proposing to provide options on the credit transfer form to identify the proposed credit transfer with a zero-dollar price in three categories. First, credit transfers that reflect an adjustment or true up in CI value of fuel transacted between buyer and seller. Second, the credit transfers that incorporate a credit trade along with the sale or purchase of other products, and does not specify a price or cost basis for the sale of the credits alone. In such cases, seller should provide a brief description of the pricing method.

### Rationale Supporting Proposed Solution

This change will allow CARB to separately identify the credit transfers with a zero-dollar price without skewing the pricing data published as part of weekly or monthly LCFS credit activity reports.

## **Section 95487(c)(1)(C)(8). Forward Credit Transfers**

### Description of Problem

Please see the problem for section 95487(c)(1)(B), above.

### Proposed Solution

Staff is proposing to provide entities options to identify and relate the proposed credit transfer with another credit transfer that has been already reported in the LRT-CBTS and share the common transaction agreement.

### Rationale Supporting Proposed Solution

Please see the rationale for section 95487(c)(1)(B), above.

## **Section 95487(c)(1)(E). Recording a Credit Transfer**

### Description of Problem

The current regulation requires the Executive Officer to approve or reject a credit transfer request and update the account balance of Seller and Buyer in the LRT-CBTS within five days of receiving a completed Credit Transfer Form (CTF). However, this

process is automated and takes place instantaneously in LRT-CBTS upon Buyer's acceptance of an incoming credit transfer.

#### Proposed Solution

Staff is proposing to update the regulation to make the credit transfer process instantaneous on completion of CTF from Buyer.

#### Rationale Supporting Proposed Solution

This change reflects the current practice of recording and processing a credit transfer in the LRT-CBTS.

### **Section 95487(c)(1)(F). Authority to Cancel or Reverse a Credit Transfer**

#### Description of Problem

The credit transfers requested in the LRT-CBTS are instantaneously processed upon completion of a CTF by Seller and Buyer. The current regulation is not clear on Executive Officer's authority to cancel or revoke a proposed or a completed credit transfer in the LRT-CBTS.

#### Proposed Solution

Staff is proposing to clarify the Executive Officer's authority to cancel or revoke a proposed or a completed credit transfer in the LRT-CBTS.

#### Rationale Supporting Proposed Solution

Clear authority to cancel or revoke a proposed or a completed credit transfer in LRT-CBTS will help the Executive Officer to protect against any activities that are fraudulent or manipulative to the LCFS credit market.

### **Section 95487(c)(2). Credit Transfer for an Agreement Executed Through a Clearing Service Provider**

#### Description of Problem

Staff is proposing to allow clearing service providers to participate in the program and that could result in credits transfers for a contract arranged through a clearing service provider. However, current regulation does not provide requirements for reporting such credit transfers in the LRT-CBTS.

#### Proposed Solution

Staff is proposing to provide reporting requirements at the time of a credit transfer for a contract arranged through a clearing service provider. This would include identifying the exchange through which the transaction occurred, contract description code assigned by the exchange to the contract, date of close of trading for the contract, price at close of trading for the contract, date of delivery of LCFS credits covered by the contract.

### Rationale Supporting Proposed Solution

This change will allow CARB to identify and record information about the credit transfers arranged through clearing service providers including the date and the price at which the agreement was settled. Based on that information CARB can make informed decision and publish more relevant information related to the credit transfers.

## **Section 95487(d)(1)(E). Publishing Information About Carry Back Credits**

### Description of Problem

The current regulation requires Executive Officer to provide to the public reports containing a summary of credit generation and transfer information including, among other things, total credits transferred and used as carry back credits during the first quarter of the current compliance period. That information does not serve any significant purpose for the public.

### Proposed Solution

Staff is proposing to remove the requirement to publish the total credits transferred and used as carry back credits during the first quarter of the current compliance period.

### Rationale Supporting Proposed Solution

The categorization of credits as carryback credits is relevant only for the compliance purposes and the LRT-CBTS does not differentiate them from other credits in the LCFS credit market based on vintage years. Thus, staff considers that publishing information on the carryback credits in addition to the information listed in section 95487(d)(1) does not provide any additional value to the stakeholders.

## **SECTION 95488. FUEL PATHWAYS.**

### **Section 95488. Restructuring and Strikeout**

### Description of Problem

In the current regulation section 95488, entitled “Obtaining and Using Fuel Pathways,” describes the process and requirements for submitting fuel pathway applications, determining the carbon intensity, and the certification process. The section prints out as 36 pages, and is difficult to read.

### Proposed Solution

In order to clarify requirements in this section and streamline the application process, 95488 has been significantly restructured under staff’s proposal. To reduce the level of indentation, the current 95488 section has been divided into 11 sections, 95488 through 95488.10, and is broken down by specific topic areas to assist readers in locating the relevant provisions. The text of the current section has been struck out in its original location.

Summaries of the contents of the proposed sections are described below:

95488. Entities Eligible to Apply for Fuel Pathways. This section introduces the applicability of the sections covering the fuel pathway application process and requirements, and adds the option for multiple facilities that contribute to a single pathway to apply as joint pathway applicants, or identify a single applicant who assumes the responsibilities of a fuel pathway applicant during the application process. The section also includes requirements for existing pathways to transition from the current CA-GREET2.0 to CA-GREET3.0, and the process for updating a certified CI.

95488.1. Fuel Pathway Classifications. This section details proposed fuel pathway classifications—which include Lookup Table, Tier 1 (with attendant Simplified CI Calculators), and Tier 2 pathways.

95488.2. Relationship Between Pathway Registration and Facility Registration. This section describes the proposed requirements to initiate a fuel pathway application in the Alternative Fuels Portal (AFP).

95488.3. Calculation of Fuel Carbon Intensities. This section lists the tools that can be used to determine carbon intensities for fuel pathways using a suite of Board-adopted life cycle analysis models: CA-GREET3.0, OPGEE2.0, GTAP-BIO and AEZ-EF models.

95488.4. Relationship of Pathway Carbon Intensities to Units of Fuel Sold in California. This section includes requirements for facilities with multiple pathways for mixed feedstocks or multiple coproducts to attribute volumes accurately to each fuel pathway code.

95488.5. Lookup Table Fuel Pathway Application Requirements and Certification Process.

95488.6. Tier 1 Fuel Pathway Application Requirements and Certification Process.

95488.7. Tier 2 Fuel Pathway Application Requirements and Certification Process.

95488.8. Fuel Pathway Application Requirements Applying to All Classifications. This section covers proposed application requirements that apply to all pathway types, including new requirements for specified source feedstocks, provisions for accounting for renewable electricity, measurement accuracy and missing data requirements, and more.

95488.9. Special Circumstances for Fuel Pathway Applications. This section outlines provisions only used in specific situations. Subsections within 95488.8 include substantiality requirements, Temporary fuel pathways, Provisional pathways, Substitute Pathways and new provisions for Design-Based pathways.

95488.10. Maintaining Fuel Pathways. This section was added to describe responsibilities of fuel pathway holders after certification is complete.



### Rationale Supporting Proposed Solution

The proposed restructuring makes it easier to locate requirements pertinent to specific LCFS pathway applicants and participants.

### **Section 95488(a) through (b). Entities Eligible to Apply for Fuel Pathways and Requirements for Joint Applicants.**

#### Description of Problem

Fuel pathway applications contain data for several phases of the source-to-tank life cycle of the fuel. For some fuel pathways, data availability may reside with an entity external to the fuel pathway applicant (i.e., low-energy rendered tallow). Currently, entities not designated as the fuel pathway applicant are not subject to the same requirements for pathway application, attestations, validation, verification and recordkeeping as the fuel pathway applicant. Clearer roles and responsibilities are needed to ensure that reliable and verifiable data are submitted when multiple entities contribute to a fuel pathway application.

#### Proposed Solution

Staff proposes in subsection (a) that any alternative fuel provider may apply for pathway certification. Provided that the entity who elects to become a fuel pathway applicant meets all requirements for certification and maintaining a fuel pathway, the Executive Officer will not deny any person the opportunity to submit an application and request certification.

Subsection (b) states that all parties contributing site-specific data to a fuel pathway application may either apply as “joint applicants” to the pathway, or designate a ‘single’ entity as the pathway applicant. For “joint applicants”, all parties apply jointly as applicants in the AFP and submit site-specific data separately (i.e. to maintain confidentiality of operational data) in the AFP. When applying as a single entity, the application is submitted by one party but includes site-specific data from all parties involved. Staff proposes that joint applicants be subject to all requirements for pathway application, attestations, validation, verification and recordkeeping, for the portion of the pathway for which they submit site-specific data. Designating a single entity as the fuel pathway applicant would not relieve other entities from obligations related to the accuracy of submitted site-specific data.

#### Rationale Supporting Proposed Solution

Accountability for data supporting pathway CI needs to be preserved for all steps of a fuel pathway application to ensure accurate accounting of greenhouse gas emissions. The proposed requirements for joint-applicant responsibility or designation of a single fuel pathway applicant facilitate submission of accurate site-specific data and accountability from all entities involved in a fuel pathway application.

## **Section 95488(c). Implementing New Application Requirements**

### Description of Problem

The current regulation lists a timeline and process for ‘recertification’ of existing fuel pathways using the CA-GREET2.0 model effective January 1, 2016.

This timeline and process is now expired, and a new process is needed to transition existing certified pathways to use the CA-GREET3.0 model and to obtain validation services.

### Proposed Solution

The proposed regulation mandates initial validation of most pathways to be eligible for certification of pathway CI. The requirement to validate a pathway CI with the most current operational data renders ‘recertification’ using legacy data irrelevant. The Executive Officer is therefore not proposing to offer ‘recertification’ of previously certified pathways. Staff proposes to delete all language referring to deactivation schedule, recertifications and batch processing of pathways in section 95488(a) of the current regulation.

Staff proposes that all fuel pathways certified before January 1, 2019 will be eligible to generate credits only through data year 2020. No new pathways will be certified under CA-GREET2.0 in 2019—all new pathways certified in and after 2019 must use the CA-GREET3.0 model. Pathways certified in 2019 will be validated by the Executive Officer to allow time for verifier training and accreditation; the third-party validation requirement will apply to submitted applications pending on Jan 1, 2020 and new applications submitted thereafter. Beyond the 2020 data year, all pathway applicants must ensure pathways are validated and certified in conformance with the proposed regulation on or before January 1, 2021 in order to be eligible to generate credits for fuel transactions in data year 2021 and beyond.

### Rationale Supporting Proposed Solution

With the proposed regulation requiring validation with the most current two years of operational data, provisions for recertification are irrelevant.

Since the recertification terminology is an artifact of the prior re-adoption of the rule, they are not being proposed for these amendments. Therefore, there will be no requirement to specify a batch processing schedule. The provisions described in 95488(c) are included to facilitate transition to the new CA-GREET3.0 model while providing flexibility for entities in the first year of the new model’s availability.

## **SECTION 95488.1 FUEL PATHWAY CLASSIFICATIONS.**

### **Section 95488.1(a). Fuel Pathway Classifications**

#### Description of Problem

The current regulation has two primary pathway classifications, Tier 1 and Tier 2 which affect the requirements for application materials. Tier 2 currently contains three sub-classifications which vary broadly in their requirements and complexity.

#### Proposed Solution

Staff proposes to streamline the pathway application process by simplifying the fuel pathway classifications. The current proposal includes three distinct classification types: Lookup Table, Tier 1 and Tier 2. Proposed changes to pathway classifications are detailed in the “Proposed Solution” for sections 95488.1(b), (c) and (d).

#### Rationale Supporting Proposed Solution

The three proposed classifications form a simpler structure for distinguishing requirements among the application requirements for various fuel types.

### **Section 95488.1(b). Lookup Table Classification**

#### Description of Problem

The Lookup Table pathways are currently classified under the Tier 2 category, which could unintentionally connote significant requirements for pathway certification. The original intent of Lookup Table pathways was to ensure expeditious processing of such pathway applications with limited pathway details from applicants. There are not currently pathway provisions for decreasing carbon intensity for electricity used for EV charging or electrolytic hydrogen production.

#### Proposed Solution

Staff proposes to include Lookup Table pathways as a separate pathway classification. The updated Lookup Table in staff’s proposal contains fuel pathways developed by staff using conservative input variables and assumptions. Staff expects that pathway application and certification for Lookup Table pathways will be expedited, easing the application process for pathway applicants. Staff also proposes that fuel pathway applicants register in the AFP and provide additional documentation to use low-CI electricity pathways from the Lookup Table.

#### Rationale Supporting Proposed Solution

The inclusion of Lookup Table pathways under a separate classification streamlines the application process and clarifies requirements for these pathways. Lookup Table pathways generally have well-defined life cycle carbon emissions with conservative inputs, posing a low risk of under-counting pathway GHG emissions. Additional records are necessary to ensure that electricity reported under a low-CI electricity pathway for electric vehicle charging and electrolytic hydrogen production is utilizing qualifying low-CI resources under an approved arrangement.

## **Section 95488.1(b)(1). Lookup Table Pathways that do not Require a Fuel Pathway Application**

### Description of Problem

Lookup Table pathways have been established for several different fuels. The majority of these proposed Lookup Table pathways have been developed using average values for inputs into the CA-GREET3.0 model, which are not expected to vary significantly across providers of the fuel.

### Proposed Solution

Staff proposes that providers of certain fuels may bypass the fuel pathway application process. Fuel reporting entities for these pathways would be able to directly report fuel volumes in the LRT-CBTS without registering for an account in the AFP nor submitting an application containing site-specific data. The Lookup Table pathways for California Gasoline Blendstock (CARBOB), California Ultra-low Sulfur Diesel (ULSD), CNG from North American Fossil Natural Gas, Propane Derived from Fossil Fuel Sources, and Electric Vehicle Charging using California Average Grid Electricity fall into this category. If an applicant's processes are misrepresented by the standard Lookup Table inputs, the applicant should consider submitting a Tier 2 pathway.

### Rationale Supporting Proposed Solution

Assigning an average CI value for these Lookup Table pathways would reduce application preparation time for many fuel providers as well as staff's evaluation and processing time without compromising data quality.

## **Section 95488.1(b)(1)(D). Addition of Propane to the Lookup Table**

### Description of Problem

With the proposed inclusion of propane, every reporting entity for fossil-based propane will be required to submit a pathway application to obtain a certified CI. If an application containing site-specific data were to be required, this would place an undue burden on applicants with no measureable advantage or accuracy improvement.

### Proposed Solution

As with fossil-derived natural gas, there are no measurable differences in the life cycle GHG emissions of fossil-based propane between applicants. Staff therefore proposes to include a Lookup Table pathway for this fuel. Fuel reporting entities for these Lookup Table pathways would not require submission of site-specific data and could report fuel quantities directly in the LRT-CBTS without registering in the AFP.

### Rationale Supporting Proposed Solution

Providing a Lookup Table pathway for fossil-based propane streamlines the application process and expedites pathway certification for the reporting of fossil-propane quantities in the LCFS. The propane transportation industry is relatively small, and providers may not find it economically rational to dedicate resources to determine more complex CIs.

See also the problem, solution and rationale for section 95482(a)(12) and the description of the addition of fossil-based propane in Chapter II.

### **Section 95488.1(b)(2). Lookup Table Pathways that Require a Fuel Pathway Application**

#### Description of Problem

Lookup Table pathways utilizing renewable feedstocks or process energy sources require documentation to ensure the fuel is eligible to use the CI provided in the Lookup Table. The Lookup Table also contains multiple hydrogen pathways, rather than a single average CI for hydrogen; a process is needed to ensure the correct pathway is selected.

#### Proposed Solution

Lookup Table pathways which require a fuel pathway application include: electricity from solar or wind-generated electricity; Electricity associated with Time-of-Use Pathways for use in EVs and hydrogen production through electrolysis; Hydrogen from central reforming of natural gas or biomethane; and Hydrogen from electrolysis using California average grid electricity or using solar- or wind-generated electricity. For these pathways, staff proposes that applicants be required to submit an application. See the problem, solution, and rationale for section 95488.5(f) for more information on Time-of-Use pathways.

#### Rationale Supporting Proposed Solution

The carbon intensity of renewable electricity generated by wind turbines or solar photovoltaics does not vary significantly, making this pathway ideal for inclusion in the Lookup Table; however, a process is needed to ensure that staff has an opportunity to determine that the source and the accounting mechanisms used to attribute the electricity to a fuel pathway meet the requirements of the regulation.

The CI associated with hydrogen pathways may vary significantly depending on the technology used to produce the fuel and on conditions such as whether the hydrogen is liquefied for transport, and the distance by which it is transported. Staff has determined conservative CI values for five representative pathways for inclusion in the Lookup Table in order to provide a simple, expedient option for providers of that fuel for two reasons: 1) because the hydrogen transportation industry is small, and providers may not find it economically rational to dedicate resources to determine a more complex CI; and 2) because hydrogen fuel will be required to be reported to the LCFS (see the solution for section 95482(b)(2) for more information). An application process is needed to ensure that the actual physical pathway conforms to the selected Lookup Table pathway.

## **Section 95488.1(c). Tier 1 Classification**

### Description of Problem

A Tier 1 fuel pathway in the current regulation is defined as a conventionally produced alternative fuel type, which has been in production for at least 3 years. “Conventionally produced” is defined as using grid electricity, natural gas and/or coal for process energy and with pre-defined co-products. This classification cannot be expanded to cover pathway applications under the Tier 1 umbrella when renewable process energy is used by the facility or if the co-product streams are different compared to the baseline Tier 1 pathway. Therefore, the current rule requires the applicant to apply using a Tier 2 pathway with significant additional documentation and time required for certification.

### Proposed Solution

Staff proposes to include provisions in the regulation to account for innovative methods of fuel production or allow for production specific co-products for fuels, which currently are included under the Tier 1 classification. Staff is proposing to use Simplified CI Calculators, which include provisions to account for some innovative process energy options and modifiable co-product streams.

### Rationale Supporting Proposed Solution

The inclusion of innovative process energy modes and variable co-product streams is expected to significantly expedite review and certification of Tier 1 pathways. Combined with the use of Simplified CI Calculators designed around facilitating validation (and verification in future years), the inclusion of these options expedites fuel pathway verification and certification.

## **Section 95488.1(c)(1). Tier 1 Corn Fiber Ethanol Pathways**

### Description of Problem

Current Tier 1 ethanol pathways include only those produced from starch (corn and grain sorghum) and sugarcane feedstocks. Edeniq has developed a proprietary technology which converts cellulose in corn fiber to ethanol. This technology is expected to be deployed industry-wide over the next few years. In the current framework, this approach would require a Tier 2 pathway for corn fiber ethanol.

### Proposed Solution

Staff proposes to include corn fiber ethanol produced using the Edeniq process under the Tier 1 classification and evaluate its CI using the Simplified CI Calculator.

### Rationale Supporting Proposed Solution

The Edeniq process has been approved for use under the U.S. EPA Renewable Fuel Standard (RFS) and staff expects to receive several applications from facilities using this pathway before the end of 2018. The addition of the corn fiber process to the Simplified CI Calculator would allow a facility that produces ethanol from both starch and fiber to use the Tier 1 application framework, which would simplify the mass balance of feedstocks and finished fuels for such facilities. Inclusion of the corn fiber

process in the current starch ethanol classification is expected to expedite pathway validation, certification, and verification.

### **Section 95488.1(c)(2). Tier 1 Biodiesel Pathways**

#### Description of Problem

The term “conventional” is used to describe biodiesel under the Tier 1 classification, but staff is proposing to expand the Tier 1 classification to allow for fuel pathways that do not fit the current regulation’s definition of conventionally produced. In addition, some of the biodiesel feedstocks could be more clearly defined to enable third-party verifiers to verify that feedstocks are correctly characterized.

#### Proposed Solution

Staff proposes to delete reference to “conventional” biodiesel. Staff also proposes to add additional detail to the types of feedstocks included in this subsection, including changing “plant” to “oilseed crop-derived” oils, specifying “rendered animal fat” rather than “tallow,” and clarifying that “corn oil” refers to “distiller’s corn oil.”

#### Rationale Supporting Proposed Solution

These changes add clarity to the regulation and are expected to facilitate the proposed mandatory verification element of the LCFS program. The proposed removal of the term “conventional” from Tier 1 Biodiesel Pathways is consistent with the goal of streamlining the pathway application and certification process.

### **Section 95488.1(c)(3). Tier 1 Renewable Diesel Pathways**

#### Description of Problem

Renewable diesel produced from co-processing in a petroleum refinery is significantly more complex than hydrotreating in a stand-alone reactor, and may not be suitable for a Tier 1 framework. Furthermore, feedstocks used in renewable diesel production could be more clearly defined.

#### Proposed Solution

Staff proposes to delete reference to “conventional” renewable diesel. Staff proposes that only renewable diesel produced by hydrotreatment of the feedstock in a stand-alone reactor would be eligible for the Tier 1 framework. Renewable diesel produced from co-processing feedstocks in conventional petroleum refineries, will be modeled as Tier 2 fuel pathways, given the complexity in calculating fuel volumes and corresponding CIs.

#### Rationale Supporting Proposed Solution

See the rationale for section 95488.1(c)(2) for removal of “conventional.” Evaluating co-processing pathways using a Tier 2 framework is consistent with the goal of streamlining the pathway application and certification process.

## **Section 95488.1(c)(4). Tier 1 Natural Gas Pathways**

### Description of Problem

The current Tier 1 classification for fossil North American natural gas used as compressed natural gas (CNG) requires applicants to supply energy use data for each CNG station, and staff has determined that the pathways do not vary significantly between applicants.

### Proposed Solution

Staff is proposing to remove the fossil natural gas to CNG pathway from the Tier 1 classification and add it to the Lookup Table. Fossil natural gas to LNG and L-CNG remain under the Tier 1 pathway classification, as liquefaction efficiency and transportation parameters contribute to larger CI differences among pathways involving liquefaction.

### Rationale Supporting Proposed Solution

Expediency of pathway certification is a benefit for both pathway applicants and CARB. The proposed inclusion of a fossil CNG pathway in the Lookup Table, which fuel suppliers can use without a formal pathway application, is a logical move towards expediting and streamlining pathway applications.

## **Section 95488.1(c)(5). Tier 1 Landfill Gas Pathways**

### Description of Problem

The current regulation does not specify geographic locations of biomethane from landfills.

### Proposed Solution

Staff proposes to specify that biomethane only from North American landfills may apply for Tier 1 pathways.

### Rationale Supporting Proposed Solution

The proposed solution clarifies that only North American landfill gas may qualify for the Tier 1 classification, as the Simplified CI calculator uses fugitive emission parameters that are applicable to the common carrier pipeline in this region. Biomethane produced from sources beyond the North American continent may apply for Tier 2 pathways to determine the emissions associated with other transportation modes.

## **Section 95488.1(d)(5). Tier 2 Drop-in Fuels**

### Description of Problem

Renewable diesel produced by co-processing renewable- and fossil-derived feedstocks at a petroleum refinery has a significantly different CI and application requirements compared to renewable diesel produced by hydrotreating in a stand-alone reactor.



### Proposed Solution

Staff proposes to include renewable diesel co-processed with fossil feedstocks in petroleum refineries under the Tier 2 classification.

### Rationale Supporting Proposed Solution

Co-processing in a petroleum refinery to produce renewable diesel is a complex process best modeled using a Tier 2 framework.

## **Section 95488.1(d)(7). Pathways using Innovative Production Methods**

### Description of Problem

In the current regulation, innovative production methods include, among others, process innovations that improve process efficiency such that the resulting CI is at least 20 percent lower due to the innovation. This requirement may limit incorporation of advancements in technology that may provide CI improvements less than 20 percent relative to the originally certified pathway.

### Proposed Solution

Staff proposes to reduce the percent threshold requirement for CI reductions resulting from process innovations and clarify that an applicant who claims their actual physical pathway cannot accurately be modeled using the simplified CI Calculator must meet the substantiality requirement in order to apply as a Tier 2 pathway. See the problem, solution, and rationale for section 95488.9(a) for the substantiality requirements. Fuels that cannot be modeled using the Simplified CI Calculator because they are produced from feedstocks that are not included in the Calculator are not required to meet the substantiality requirements to qualify for a Tier 2 pathway.

### Rationale Supporting Proposed Solution

The 20 percent substantiality threshold imposed by the current regulation potentially disincentivizes the adoption of process innovations. The proposed requirements have smaller thresholds for CI reductions and are likely to spur the inclusion of process innovations in the fuel production process, allowing these pathways to be modeled more accurately.

## **SECTION 95488.2. PATHWAY AND FACILITY REGISTRATION.**

### Description of Problem

The process for initiating a pathway application in the AFP must be updated and clarified.

### Proposed Solution

Staff proposes to relocate requirements for fuel pathway applicants to register in the AFP to section 95483.2 along with other account registrations, and replace language describing the “new pathway request form” with “production facility registration and pathway registration,” which guides applicants through the pathway application process

in the AFP. The provisions of 95488.2 do not apply to entities seeking to report fuel transactions for the Lookup Table pathways listed in 95488.1(b)(1).

#### Rationale Supporting Proposed Solution

These updates are being proposed to enhance clarity in the pathway application process.

### **Section 95488.2(a). Production and Intermediate Facility Registration**

#### Description of Problem

The current regulation does not explicitly require that all production facilities be registered in the AFP.

#### Proposed Solution

Staff proposes that all production facilities from which site-specific data is relied upon for calculating the pathway CI must register in the AFP. The proposed amendments to the regulation define production facilities as a facility in which a fuel is produced. All of these facilities must register in the AFP. Intermediate facilities, from which site-specific data is used in determination of a fuel pathway carbon intensity, including feedstock processing facilities, must also be registered.

#### Rationale Supporting Proposed Solution

This requirement is in line with the proposed updated definition of production and intermediate facilities and requirements for joint applicants, and provides a greater level of accountability for all steps of a fuel pathway application.

### **Section 95488.2(a)(2). Generation of Company ID by AFP**

#### Description of Problem

The current regulation states that the LRT-CBTS system will generate a company ID for fuels not covered by the federal RFS program. This task is intended to be completed by the AFP, not the LRT-CBTS.

#### Proposed Solution

Staff proposes that the AFP system will generate a company ID for fuels not covered by the federal RFS program, instead of the LRT-CBTS.

#### Rationale Supporting Proposed Solution

The AFP is the intended system used for registration of production and intermediate facilities, and is therefore the ideal program to generate a company ID for fuels not covered by the federal RFS program.

## **Section 95488.2(b)(6). Annual Quantity of Fuel Produced**

### Description of Problem

The pathway registration section requires that a fuel pathway applicant provide an estimated representative annual quantity of fuel produced under the proposed pathway. However, requiring a single value for estimated annual fuel production is not as useful as requiring an expected annual fuel production range.

### Proposed Solution

Staff proposes to require fuel pathway applicants to provide minimum, maximum and average historical (if applicable) or expected fuel production quantities, in the units specified for reporting purposes.

### Rationale Supporting Proposed Solution

Providing a range and an average quantity of expected annual fuel production for each pathway better describes a facility's scale of production than a single estimated value, and is needed for staff's planning for program oversight audits.

## **SECTION 95488.3. CALCULATION OF FUEL PATHWAY CARBON INTENSITIES.**

### **Section 95488.3(a) through (b). Updated CA-GREET Model and New Tier 1 Calculators**

### Description of Problem

A new version of Argonne National Lab's GREET model, GREET 2016, is now available, with updated emission factors, life cycle inventory data, and assumptions. The existing model incorporated under the current regulation, CA-GREET2.0, is based on a prior version of the GREET model.

The existing Tier 1 Calculator is based on the CA-GREET2.0 model. See also the problem for section 95488.6(a)(1) for additional discussion regarding the need to update the Tier 1 modeling framework.

### Proposed Solution

Staff developed CA-GREET3.0 using the most current version of the Argonne GREET model. Staff proposes to replace CA-GREET2.0 and use the CA-GREET3.0 model for determining CIs in the LCFS. Consistent with the current regulation, another model determined by the Executive Officer to be equivalent or superior to the CA-GREET3.0 model may also be used, under the proposal.

In addition, staff proposes to incorporate by reference the following Tier 1 Simplified CI Calculators:

- (1) Tier 1 Simplified CI Calculator for Starch and Corn-Fiber Ethanol
- (2) Tier 1 Simplified CI Calculator for Sugarcane-derived Ethanol
- (3) Tier 1 Simplified CI Calculator for Biodiesel and Renewable Diesel

- (4) Tier 1 Simplified CI Calculator for LNG and L-CNG from North American Natural Gas
- (5) Tier 1 Simplified CI Calculator for Biomethane from North American Landfills

See also the proposed solution for section 95488.6(a)(1) for a thorough description of the Simplified CI Calculators.

#### Rationale Supporting Proposed Solution

The GREET 2016 model contains updates based on more current data and more accurately represents emission factors and process conditions than previous versions. This update is consistent with staff's historical practice of updating the CA-GREET model using the most current version of Argonne's GREET model with California-specific modifications. Appendix C of this Staff Report includes the CA-GREET3.0 Supplemental Document and Tables of Changes that documents the modifications that staff made to GREET 2016 to develop the CA-GREET3.0 model. See also the rationale for section 95488.6(a)(1) regarding the Simplified CI Calculators.

### **Section 95488.3(c). Updated OPGEE Model**

#### Description of Problem

A new version of the OPGEE model has been released (OPGEE2.0) reflecting updates to the carbon intensities for crude oil. The existing model in the current rule is OPGEE1.1 and does not incorporate the most current data for crude oil life cycles.

#### Proposed Solution

Staff proposes to utilize the OPGEE2.0 model for determining the CI of crude oil in the LCFS.

#### Rationale Supporting Proposed Solution

The OPGEE2.0 model contains the most current data used for determining crude oil CIs and best represents current industry practices. Staff used the CIs of crude oil generated by OPGEE to calculate the proposed CI of Ultra-Low Sulfur Diesel (ULSD) and California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB). The same rationale used for updating to the latest GREET model applies in adopting the newest version of OPGEE. The current regulation also states in section 95489(b)(3)(C) that updates to all CI values listed in the Carbon Intensity Lookup Table for Crude Oil Production and Transport (Table 9 in the proposed amendments to the regulation) will be considered on a three-year cycle through proposed amendments to the LCFS.

### **Section 95488.3(d). Approvals of New Land Use Change Modifiers**

#### Description of Problem

The current regulation does not allow for the addition of a new land use change (LUC) modifiers without Board approval. The regulation could be more clear regarding the

options an applicant has when seeking certification of a pathway that should include a LUC modifier when one is not available in the regulation.

#### Proposed Solution

Staff proposes the Executive Officer should have the ability to determine new LUC modifiers using the same process and tools that were used in determining the Board-approved LUC modifiers in the current regulation. Alternatively, should the Executive Officer determine an existing modifier is appropriate for a new feedstock/fuel combination, the Executive Officer would require the applicant to use that modifier in determining the pathway CI.

#### Rationale Supporting Proposed Solution

Staff is currently unable to predict specific types of feedstocks likely to be utilized by fuel producers beginning in 2019. The proposed regulatory provision to create either new LUC modifiers or to apply existing LUC modifiers in Table 6 provides flexibility to account for LUC impacts for new feedstocks not currently in the regulation. It also provides for flexibility for situations where current feedstocks may be utilized to produce fuels that are currently not included in the LUC table.

### **SECTION 95488.4. RELATIONSHIP OF PATHWAY CARBON INTENSITIES TO UNITS OF FUEL SOLD IN CALIFORNIA.**

#### **Section 95488.4(a). Conservative Margin of Safety**

#### Description of Problem

The certified CI must not be exceeded to remain in compliance with the regulation. Fuel pathway CIs may potentially be affected by inherent process variability. Applicants may wish to have certified a more conservative CI than the value calculated based on operational data to diminish the risk of non-compliance by exceeding the certified CI.

#### Proposed Solution

Staff proposes to create a process for fuel pathway applicants to add an optional margin of safety at the time of application submittal. The applicant would determine the precise magnitude of this margin of safety, which would be combined exogenously with the calculated CI based on operational data to form a final certified CI. This certified CI, inclusive of an optional conservative margin of safety, would be used for reporting fuel transactions upon certification of the fuel pathway.

#### Rationale Supporting Proposed Solution

The proposed margin of safety provides fuel pathway applicants with a mechanism to account for potential variability in pathway inputs or efficiency that they may foresee, and may assist in assuring the verified operational CI is found to be compliance with the certified CI.

## **Section 95488.4(c)(1). Example of Situation in which Multiple Feedstocks are Used and Multiple Pathways Assigned**

### Description of Problem

This subsection allows for portions of fuel produced to be assigned separate CIs when two or more feedstocks are being simultaneously fed into a production process. The current regulation lists only one potential situation in which this might apply. A second example may provide additional clarification related to assignment of separate CIs when more than one feedstock is used in a production process.

### Proposed Solution

Staff proposes to add a second example to provide additional clarification. In the steam methane reforming (SMR) process, fossil natural gas and biomethane (including biomethane procured using book-and-claim accounting) may be utilized simultaneously as feedstocks in the production of hydrogen. For such a production process, separate carbon intensities will be assigned to hydrogen produced from fossil natural gas and biomethane.

### Rationale Supporting Proposed Solution

This is intended to provide additional clarification for fuel producers with multiple feedstocks to enable accurate reporting of fuel volumes corresponding to respective feedstocks.

## **Section 95488.4(d). Average Yield for Multiple Feedstocks**

### Description of Problem

The current regulation specifies that, when multiple simultaneous feedstocks are used in the production process, fuel producers must track and report the portion of the fuel produced with each feedstock, using the producer's average feedstock-specific mass-based fuel yield values. This may imply that the average yield per feedstock must be used, which is inconsistent with the proposed methodology for facilities utilizing multiple feedstocks in the production process. In addition, a mass-based approach to calculating average fuel yield values is not an appropriate approach for certain fuels (i.e., hydrogen).

### Proposed Solution

Staff proposes to use a production facility average fuel yield to associate appropriate volumes of fuel produced when multiple feedstocks are utilized in the production process. The allocation would be performed on a mass or energy basis as appropriate.

### Rationale Supporting Proposed Solution

When multiple feedstocks are used in the production process, the Simplified CI Calculators, as designed, require inputs for all feedstock quantities and all energy consumed at the plant. The facility average yield is then calculated using this information to generate feedstock-specific CIs for different feedstocks.

## **SECTION 95488.5. LOOKUP TABLE FUEL PATHWAY APPLICATION REQUIREMENTS AND CERTIFICATION PROCESS.**

### **Section 95488.5. Removal of References to Method 2A or 2B Pathways**

#### Description of Problem

In the current regulation, Lookup Table fuel pathway applicants with a pathway CI higher than its closely matched Lookup Table pathway are advised to seek a Method 2A or 2B pathway.

#### Proposed Solution

Staff is proposing to eliminate the Method 2A and 2B classifications. The Method 2A and Method 2B classifications add additional complexity for pathway applicants. In addition, Method 2A has not been utilized by any of the pathway applicants who have elected to use Tier 2 pathways. Staff therefore proposes to replace references to Method 2A and 2B with a single Tier 2 pathway classification.

#### Rationale Supporting Proposed Solution

As specified in 95488.1, staff proposes to streamline and simplify fuel pathway classifications and, consistent with this objective, pathway classification is being proposed to include three distinct classifications: Lookup Table, Tier 1 and Tier 2.

### **Section 95488.5(b)(1) through (3). Application Requirements for Lookup Table Pathways**

#### Description of Problem

Since staff is proposing to add new pathways for low-CI inputs used in electricity and hydrogen pathways, specific documentation requirements for Lookup Table pathway applications are needed.

#### Proposed Solution

Staff proposes that entities seeking approval to use the wind and solar electricity Lookup Table pathway, the Time-of-Use pathways, or any Hydrogen Lookup Table pathway, must submit an attestation letter pursuant to the requirements of 95488.8(a).

Staff proposes to require applicants for solar- or wind-generated electricity supplied to EVs to provide meter records and documentation of the locations of equipment if electricity is provided behind the meter. If a book-and-claim accounting system is used to attribute off-site renewable electricity to EV charging, contracts and invoices documenting the source and quantity of electricity that is claimed are required pursuant to 95488.8(i)(1).

Staff proposes to require applicants for Time-of-Use pathways to provide metering records for the latest quarter to demonstrate that the entity can provide such records to verify electricity use by hourly periods. See the problem, solution, and rationale for section 95488.5(f) for more information on Time-of-Use pathways.

Staff proposes to require applicants for hydrogen pathways to 1) acknowledge that they have reviewed and understood the pathway conditions and note any exceptions, and 2) provide station energy use, dispensation and performance data that is commonly provided by hydrogen stations to the National Renewable Energy Laboratory (NREL), if such data is available. If renewable hydrogen is produced, applicants must provide documentation to support and quantify renewable feedstocks (biomethane) or electricity. Contracts and invoices from the landfill gas upgrading facility (or another source supplying the biomethane) are required for tracking of environmental attributes associated with biomethane, pursuant to the requirements of section 95488.8(i)(2).

#### Rationale Supporting Proposed Solution

The documentation requirements will assist staff in ensuring that GHG reductions are not double counted, that renewable electricity and biomethane meet the requirements of the regulation, and to determine what documentation will be required on an annual basis to verify the CI. The requirement to submit an attestation letter ensures that the fuel pathway applicant will exercise due diligence when they select the Lookup Table pathway which closely corresponds to their actual fuel pathway. In proposing this solution staff intends to balance the desire to maintain a simple and streamlined application process with adequate assurance of accuracy in GHG reduction claims.

### **Section 95488.5(c). Completeness Check**

#### Description of Problem

The proposed Lookup Table pathways requiring fuel pathway applications are required to submit documentation evidencing their use of low-CI inputs. A process must be established for the Executive Officer to review the documentation provided.

#### Proposed Solution

Staff proposes to conduct a completeness check for renewable electricity and hydrogen Lookup Table fuel pathway applications. The completeness check will ensure that the documentation meets the requirements of 95488.8(h), or 95488.8(i), as applicable, for all renewable or low-CI feedstocks and process energy. Staff proposes that fuel pathway applicants who do not address requests for additional information within 15 business days will have their pathways rejected, and must reapply to participate in the program.

#### Rationale Supporting Proposed Solution

The proposed solution creates a process by which CARB can ensure that fuel pathway applicants are submitting complete applications and are fully aware of the conditions to which their pathway must conform for the Lookup Table pathway they have selected.



## **Section 95488.5(d). Annual Update of Lookup Table Pathways for California Average Grid Electricity**

### Description of Problem

The current Lookup Table pathway for California Average Grid Electricity supplied to electric vehicles uses generation resource mix data from the U.S. EPA's eGRID2014 database to calculate the pathway CI. Annual updates to this database are typically published two to three years after each data year. Under the current regulation, Lookup Table CI values are only updated when the LCFS program undergoes a formal rulemaking, which has typically occurred roughly once every three years (2009, 2011, 2015, and 2018). The contributions from renewables in the California electricity mix are changing annually due to mandates driven by the RPS and the inclusion of Cap-and-Trade carbon pricing in dispatch models. This has the effect of significantly decreasing the carbon footprint relatively quickly. The impact of such changes are not currently captured until an amendment is certified by the Board. Similarly, for time-of-use electricity, curtailment patterns are likely to change given increased use of solar and wind in California each year.

### Proposed Solution

Staff proposes to update the California Average Grid Electricity pathway CI value annually. Staff proposes that this CI would be updated using the methodology described in the Lookup Table Pathways Technical Support Documentation, included in Appendix C of this Staff Report.

Quarterly data pertaining to curtailment patterns will be regularly updated so that carbon intensities for Time-of-Use pathways will reflect the most recent curtailment data from the prior year. See the problem, solution, and rationale for section 95488.5(f) for more information on Time-of-Use pathways.

### Rationale Supporting Proposed Solution

Updating the Lookup Table pathways for California Average Grid Electricity and Time-of-Use Electricity regularly to reflect quarterly curtailment trends may incentivize emission reduction through transportation electrification by more accurately reflecting the decreasing carbon intensity of the California electricity grid.

## **Section 95488.5(e). Revisions to the Lookup Table**

The following table provides the Problem, Solution and Rationale for each proposed changes to the Lookup Table (Table 7-1 in the proposed regulation order, Table 6 in the current regulation).

**Table III-1: Specific Purpose and Rationale for Proposed Changes to Lookup Table Pathways**

<b><i>Description of Problem</i></b>	<b><i>Proposed Solution: Modification to Table 7-1</i></b>	<b><i>Rationale Supporting Proposed Solution</i></b>
The current pathway CIs are determined using CA-GREET2.0	Staff proposes to update all CIs using CA-GREET3.0	For consistency with the CI benchmarks and other fuel pathways, all certified pathways should have CIs determined using the same model.
See the problem for section 95488.1(c)(4). New pathway for North American fossil-derived natural gas as CNG – see Chapter II documentation for proposed changes.	Staff proposes to add North American Natural Gas to CNG to the Lookup Table.	See the rationale for section 95488.1(c)(4).
See Chapter II and Description of Problem for section 95482(a)(12). Staff is proposing to remove the exemption for fossil-based propane.	Staff proposes to add fossil-based propane to the Lookup Table.	Staff has determined an average CI applicable to all fossil-based propane.
Biomethane pathways in the Lookup Table are rarely utilized and represent complex life cycles, which are difficult to standardize between pathway applicants.	Staff proposes to remove biomethane pathways from the Lookup Table.	Biomethane pathways from anaerobic digestion of food and green wastes and from wastewater treatment are complex by nature and are better suited for the Tier 2 framework.
Solar- or wind-generated electricity used for charging of electric vehicles is only available as a Tier 2 pathway, which may limit applicants from applying for pathways using renewable electricity for charging of electric vehicles.	Staff proposes to add a pathway for solar- or wind-generated electricity to the Lookup Table.	Tier 2 documentation requirements are unnecessary for such pathways, which have pre-determined pathway CIs. Adding renewable electricity pathway to the Lookup Table expedites and incentivizes participation in the LCFS by streamlining and simplifying application requirements.
The current Lookup Table does not include a	Staff proposes to add a pathway for liquefied	Hydrogen may be liquefied to improve the economics of

pathway for liquefied hydrogen produced by steam reforming of biomethane.	renewable hydrogen produced from biomethane.	fuel transport. This addition allows providers of liquefied hydrogen to use the Lookup Table.
Hydrogen produced by electrolysis is not currently included in the Lookup Table pathway.	Staff proposes to add a pathway for hydrogen produced by electrolysis using grid electricity, and a pathway using solar- or wind-generated electricity.	Electrolysis is a growing technology option for the production of hydrogen for transportation. Adding hydrogen produced from electrolysis to the Lookup Table expedites and incentivizes participation in the LCFS by streamlining and simplifying application requirements.
The existing pathways for hydrogen produced by on-site by steam methane reforming (SMR) of natural gas may overestimate efficiency of small-scale SMR.	Staff proposes to remove pathways with on-site reforming of natural gas from the Lookup Table. Applicants may use the Lookup Table pathway for hydrogen produced by central reforming if applicable, or Tier 2.	Staff has determined that small-scale SMR units may achieve much lower efficiency than the industrial process modeled in the Lookup table. Applicants must demonstrate that they achieve the same efficiency.

**Section 95488.5(f). Time-of-Use Lookup Table Pathways**

Description of Problem

The current regulation does not allow for reductions in electricity carbon intensity due to use of electricity during periods of above- or below-average CI. During certain times of day, depending on seasonality, wind and solar electricity resources that could otherwise be used are turned off, or curtailed, due to insufficient load.

Proposed Solution

Staff proposes to create and update a Time-of-Use carbon intensity table that better reflects the hourly carbon intensity due to the probability of curtailment for wind and solar resources. This time-of-use table would be generated such that each quarter’s hourly carbon intensity reflects the quarter from the prior year.

Rationale Supporting Proposed Solution

By shifting transportation fuel generation to coincide with periods of likely curtailment, it is possible to shift demand to lower-carbon resources that would otherwise not be used. By creating hourly time-of-use tables that reflect historic curtailment likelihood, it is possible to create a simple lookup table that can be used to incentivize electric vehicle charging behaviors and electrolytic hydrogen production that is predictable and that is also likely to coincide with periods of renewable electricity curtailment. Due to the

increased use of renewable electricity that would otherwise not be used during these periods, credits generated through Time-of-Use pathways would be eligible for additional credit due to direct emission reductions.

## **SECTION 95488.6. TIER 1 FUEL PATHWAY APPLICATION REQUIREMENTS AND CERTIFICATION PROCESS.**

### **Section 95488.6(a)(1). Simplified CI Calculators**

#### Description of Problem

Although the current Tier 1 calculator is designed to simplify pathway applications for first-generation biofuels, it requires applicants to develop in-house expertise with the CA-GREET model or retain consultants to submit applications on their behalf. In addition, the use of renewable process energy or electricity is not addressed under the Tier 1 classification.

Also, with pre-defined product streams in the Tier 1 calculator, changes in co-product streams (e.g., for renewable diesel) required the migration of some fuel pathways to the Tier 2 classification, with more extensive pathway application requirements, even for fuels that were expected to be certified under the expeditious Tier 1 process.

Further, the Tier 1 calculator under the current rule does not centralize the key site-specific values. Therefore, verification by third parties of applications submitted using the current Tier 1 model would be challenging.

#### Proposed Solution

To further streamline pathway CI application, evaluation, and verification for Tier 1 pathways staff is proposing additional simplification to the Tier 1 pathway application (as a replacement for the current CA-GREET2.0 Tier 1 Calculator and operational data summary template). Similar to the current Tier 1 Calculator, the Simplified CI Calculators provide automated calculations using factors from the version of CA-GREET available for Tier 2 applications, but increase simplicity and transparency of these calculations.

The calculator collects summarized monthly operational data, which is then automatically translated to the user-defined inputs needed for the CI calculation. Using life cycle inventory data, emission factors, and certain default parameters from CA-GREET3.0, the calculator performs the needed CI calculations. This allows staff to automate any unit conversions that are currently performed by applicants, in order to simplify the application process and facilitate a direct comparison of the inputs to meter readings, data loggers, invoices, and other types of records. The proposed Simplified CI Calculators offers a simplified, transparent and standardized method of demonstrating how operational data impacts CI, and may be useful to producers on an ongoing basis to monitor variations and mitigate risk of exceeding their certified CI.

These Simplified Calculators do not require applicants to develop expertise with the CA-GREET model and are flexible to accommodate different co-product streams, ensuring that most first generation fuels would be certified under the Tier 1 classification. The Simplified CI Calculators will also facilitate third-party verification by providing a transparent and pre-defined set of operational data that must be verified through comparison to meter readings, data loggers, invoices, and other types of records.

#### Rationale Supporting Proposed Solution

Simplified CI Calculators provide an intuitive interface for fuel pathway applicants to enter operational data, removing the need for expertise with the CA-GREET model. Expectations for pathway information submittal are clear, and all required site-specific inputs for a Tier 1 fuel pathway application are marked for fuel pathway applicants. In addition, with the mandatory verification element of the proposed regulatory update, the Simplified CI Calculators enable identification of pathway specific inputs that require verification.

### **Section 95488.6(a)(1)(A). Inclusion of LUC or Indirect CI Modifiers in Simplified CI Calculators**

#### Description of Problem

Land use change impacts from crop-based fuels are part of the life cycle of the fuel and have a significant impact on CI. Land use change effects must be accounted for in the updated Simplified CI Calculators.

#### Proposed Solution

Staff proposes to continue to use the land use change CI values published in the current regulation (Table 5 of the current regulation, Table 6 in the proposed regulation), and to include these values in the Simplified CI Calculators. Land use change values would be automatically added onto applicable pathway CIs and would not be subject to adjustment based on applicant data.

#### Rationale Supporting Proposed Solution

Staff has not observed sufficient evidence in literature to justify modifying the LUC CI values for the proposed regulation. Updates to LUC CI values may be considered for future rulemakings, if appropriate.

### **Section 95488.6(a)(1)(B). Tier 1 Simplified CI Calculator Instruction Manual**

#### Description of Problem

Although the Simplified CI Calculators have intuitive user interfaces, instructions for filling out the fields, especially concerning expectations for data quality, units, and other parameters, are needed to support fuel pathway applicants when completing the Simplified CI Calculators.

### Proposed Solution

The Tier 1 Simplified CI Calculator Instruction Manual is being proposed for each fuel-specific Simplified CI Calculator. This manual contains detailed instructions for completing all required fields in the Simplified CI Calculators, including data quality requirements, units, and other parameters.

### Rationale Supporting Proposed Solution

This document ensures that the Simplified CI Calculators are used as intended in order to generate an accurate CI for use in the LCFS and to facilitate a third-party verifier during periodic verification.

## **Section 95488.6(a)(1)(C). Regional Electrical Generation Energy Mix**

### Description of Problem

For fuel or feedstock production outside the United States, process energy generation mixes are not provided in the CA-GREET model.

### Proposed Solution

Staff proposes to include provisions for the Simplified CI Calculators with a user-defined option for feedstock sourcing or fuel production facilities in regions not included in the Simplified CI Calculators. The Executive Officer will collaborate with the fuel pathway applicant to develop emission factors for applicable user-defined regions. Staff proposes to use the eGRID2014 database to define electrical generation mixes within the United States.<sup>56</sup> Staff also proposes to include national generation mixes for Brazil (data provided by UNICA)<sup>57</sup> and Canada (data from Statistics Canada).<sup>58</sup>

### Rationale Supporting Proposed Solution

Given the variability resources used to generate process energy in regions outside the U. S., it is important to account for the appropriate GHG emissions generated from upstream energy inputs to the life cycle of the fuel produced and shipped to California. The Simplified CI Calculators have been designed to include user-defined options for the generation mixes and emission factors to accommodate regions outside the U.S. Defined generation mixes are provided in the model for Brazil and Canada, which have active participants in the program.

## **Section 95488.6(a)(2). Supplemental Information**

### Description of Problem

The Simplified CI Calculators do not always capture all the relevant information to facilitate review of fuel pathway applications.

---

<sup>56</sup> U.S. Environmental Protection Agency, eGRID2014 9<sup>th</sup> edition Version 2.

<https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>

<sup>57</sup> Provided by UNICA on July 13, 2017 via email by Lais Thomas of UNICA office in Washington D.C

<sup>58</sup> Extracted from Statistics Canada on Jul 31, 2015. Table 127-0007 Electric power generation, by class of electricity producer, annual (megawatt hour).

### Proposed Solution

The application process includes provisions for providing supplemental information if required for specific circumstances. Examples include: providing the source of alternative forms of process energy supplied directly to the production facility; defining emission factors for electricity, crude and natural gas mixes for regions outside the United States; supporting evidence of additional processing outside the facility site; and automated metering equipment output to determine accurate facility energy use in the case of colocation with unrelated facilities (see also the proposed solution for section 95488.7(a)(2)(C) for additional information about the requirement for co-located facilities). Requiring this information will support staff review of pathway applications since the Simplified CI Calculators do not require such information to be included as part of uploading these calculators.

### Rationale Supporting Proposed Solution

Expediency of pathway application review prior to third-party verification is important, and provisions for the inclusion of supplemental documentation expedites the review process.

## **Section 95488.6(b)(1). Preliminary Review of Tier 1 Applications**

### Description of Problem

When pathway applications are submitted with incomplete information, a comprehensive validation of the fuel pathway application may not be possible. In addition, a fuel pathway application may not be appropriate for the classification stated, and the requested CI may not be reasonable for that particular feedstock-fuel combination.

### Proposed Solution

Staff proposes to conduct a preliminary review of the submitted Simplified CI Calculator and supplemental information.

### Rationale Supporting Proposed Solution

This preliminary screening ensures that the minimum requirements for fuel pathway applications are met. In addition, the regulation requires the submission of complete applications to enable verification of all site-specific inputs prior to consideration of certifying such pathways.

## **Section 95488.6(b)(2). Validation**

### Description of Problem

Because staff's proposal includes a requirement for third-party verification bodies to review fuel pathway applications before a pathway can be considered for certification, a process is needed to integrate this requirement within the application framework and to describe how validation outcomes impact the overall certification process.

### Proposed Solution

Staff proposes that a positive or qualified validation statement is a prerequisite for consideration of CI certification. Staff proposes that invoices, receipts and supporting documentation substantiating pathway inputs must be maintained for review by a third-party verifier during validation or verification, and available to staff upon request. Accordingly, submittal of supporting documentation such as energy and feedstock invoices to staff will no longer be required as part of a pathway application.

In addition, staff proposes that an adverse validation statement, or a failure to complete validation within six months of application submission, will result in denial of the application.

### Rationale Supporting Proposed Solution

The proposed validation of fuel pathway applications by third-party verifiers does not change the requirement to validate pathways, but transfers responsibility to validate invoices, receipts and supporting documentation from staff to the third-party verifier, and also clarifies the outcomes of third-party validation of fuel pathways.

## **Section 95488.6(b)(3)(A) through (B). Certification**

### Description of Problem

The current regulation states that a certification statement will be prepared by the Executive Officer for pathways approved for certification. The regulation does not specify information to be included in the certification statement.

### Proposed Solution

After validation of a Tier 1 fuel pathway application, the Executive Officer will evaluate the application to ensure that it has met all requirements necessary for certification. If the Executive Officer determines that the fuel pathway application has met these requirements, the Executive Officer will prepare a pathway summary of the inputs, the final CI and any limitations or conditions applicable to a fuel pathway not included in the regulatory text (these items are currently referred to as a “certification statement” in the regulation, but staff proposes to specify these components for added clarity).

### Rationale Supporting Proposed Solution

This proposed update of regulation language outlines the first two steps in the certification process after the validation step and describes details related to the pathway, which will be included by the Executive Officer at the time of certification.

## **Section 95488.6(b)(3)(C). Fuel Pathway Holders**

### Description of Problem

Under the current regulation, once a CI is certified, the applicant does not continue to submit data to ensure that the pathway remains in conformance with the certified CI. However, under staff’s proposal the applicant must demonstrate conformance on an ongoing basis.



### Proposed Solution

Staff proposes that fuel pathway applicants would become fuel pathway holders who are subject to new requirements to ensure ongoing conformance with the certified CI.

### Rationale Supporting Proposed Solution

The role is necessary to identify parties responsible for meeting the objectives of the proposed verification system as discussed in Chapter II of this Staff Report.

## **SECTION 95488.7. TIER 2 FUEL PATHWAY APPLICATION REQUIREMENTS AND CERTIFICATION PROCESS.**

### **Section 95488.7(a)(2)(A)(7). User-defined Fuel Production or Feedstock Source Regions**

*(see the problem, solution, and rationale for section 95488.6(a)(1)(C))*

### **Section 95488.7(a)(2)(A)(8). Transactional Documents to Corroborate Co-Product Credits**

### Description of Problem

Inclusion of co-product credits in the life cycle analysis of certain pathways require verification of transactions to ensure valid credits are generated for use in the LCFS program.

### Proposed Solution

Staff proposes that co-product credits which require verification must be supported with necessary transactional documents to corroborate any further processing, and the sale or use of the co-product, in a manner consistent with its life cycle accounting in the pathway analysis. Fuel pathway applicants exporting co-produced electricity must monitor the quantity transferred using data systems with electronic archival.

### Rationale Supporting Proposed Solution

Credits generated for co-product production require verification and the proposed solution addresses this requirement.

### **Section 95488.7(a)(2)(C). Requirements for Co-located Facilities**

### Description of Problem

Fuel production facilities may be co-located with other facilities whose energy inputs are shared. In order to determine the CI of a fuel pathway application, energy use data for fuel production alone must be used in the pathway application.

### Proposed Solution

Staff is proposing requiring that fuel production facilities co-located with other facilities would need to use automated metering equipment with electronic data archival to log

the energy used for operations related to the fuel pathway application. Specific proposed requirements are listed in 95488.6(a)(2)(D).

#### Rationale Supporting Proposed Solution

Site-specific energy consumption data is required for calculation of pathway CIs. This data should be specific to the fuel pathway itself and not include energy consumed or supplied by other processes.

### **Section 95488.7(d)(1). Preliminary Review of Tier 2 Applications**

#### Description of Problem

When pathway applications are submitted to the Executive Officer with incomplete information, a comprehensive evaluation of the fuel's life cycle emissions may not be possible. In addition, an incomplete fuel pathway application may limit the Executive Officer's ability to ascertain the appropriateness for a Tier 2 classification. A subsequent validation or verification may also not be possible if all required information is not submitted as part of the application.

#### Proposed Solution

Staff proposes that the Executive Officer will conduct a preliminary review of the fuel pathway application, including the LCA report, the CA-GREET3.0 model and any other submitted documentation, in order to check for completeness and confirm that the application meets the requirements for the Tier 2 classification. If the application is deemed complete and permissible from a life cycle perspective, the fuel pathway applicant then seeks the services of a verifier accredited by the Executive Officer to perform validation of the pathway.

#### Rationale Supporting Proposed Solution

This preliminary screening ensures that the application meets the minimum requirements for Tier 2 fuel pathway applications. In addition, the regulation requires the submittal of a complete application to enable verification of all site-specific inputs prior to consideration of certifying such pathways.

### **Section 95488.7(d)(2). Defining Site-Specific Inputs for Tier 2 Pathway Validation**

#### Description of Problem

Tier 2 pathways are expected to be unique, complicated and without a predetermined life cycle analysis profile. Site-specific inputs, including non-numerical parameters, subject to verification for Tier 2 pathways cannot be determined prior to a complete evaluation of the life cycle analysis, detailed input feedstocks, energy mixes, co-products and finished product streams. It is not possible, therefore, for the Executive Officer to develop a template for verification for such pathways before a complete application package has been submitted and reviewed. However, a process has to be detailed to develop a summary of all relevant pathway inputs and conditions for review by the verifier.

### Proposed Solution

For Tier 2 pathways, staff after completing a preliminary review of the application, will assist applicant to develop a template similar to the Simplified CI Calculators detailing site-specific (or pathway-specific) inputs critical in the pathway CI determination. This list will include non-numerical parameters and conditions that must be checked by the verifier during initial validation. During certification, staff will include operating conditions and other requirements (i.e., credit for co-product will be considered only if supporting evidence for final disposition is provided) to be fulfilled in order to maintain the certified CI. For on-going verification, in addition to verification of site-specific inputs detailed in the template, the third-party verifier will confirm compliance with stated operating conditions and other requirements detailed during certification.

### Rationale Supporting Proposed Solution

Defining a list of the site-specific inputs would facilitate the verification process. The process outlined in 95488.7(d)(2) provides a framework for collaboration with the applicant in defining these inputs.

#### **Section 95488.7(d)(3). Validation**

*(see the problem, solution, and rationale for section for 95488.6(b)(2))*

#### **Section 95488.7(d)(4). Engineering Review**

### Description of Problem

The section describing replication of the applicant's carbon intensity calculations in the current regulation includes a validation step by the Executive Officer for all energy consumption inputs to the fuel pathway application. Staff is no longer proposing that the Executive Officer will conduct the validation of pathway inputs.

### Proposed Solution

Staff proposes to delete reference to validation conducted by the Executive Officer from the section describing replication of the applicant's carbon intensity calculations, since staff is proposing a system for third-party verification that includes validation.

### Rationale Supporting Proposed Solution

This modification aligns the engineering review process with the proposed requirement for validation by accredited third-party verifiers under the proposed mandatory monitoring and verification component of the regulation.

#### **Section 95488.7(d)(4)(C). Pathway Summary**

### Description of Problem

The current regulation does not list the information that is included in a pathway summary.

### Proposed Solution

Staff proposes to list the items that would appear in a pathway summary, with confidential data redacted.

### Rationale Supporting Proposed Solution

To ensure transparency yet preserve confidentiality of business sensitive applicant information, posting of specific pathway details allows a meaningful public review prior to certification of Tier 2 pathways.

#### **Section 95488.7(d)(6). Fuel Pathway Holders**

*(see the problem, solution, and rationale for section 95488.6(b)(3)(C))*

### **SECTION 95488.8. FUEL PATHWAY APPLICATION REQUIREMENTS APPLYING TO ALL CLASSIFICATIONS.**

#### **Section 95488.8(a). Fuel Pathway Applicant Attestation Letter**

### Description of Problem

The Fuel Producer Attestation Letter currently may be uploaded after staff review and prior to certification of the fuel pathway application. Because all submittals are required to be true and accurate, an attestation simultaneous with an application is more consistent with that requirement.

Applicants have been required to submit an original signed copy of the attestation letter in blue ink in addition to uploading an electronic copy through the AFP. This is redundant since the electronic copy serves the purpose of a legally binding attestation by the pathway applicant. Staff has the additional burden to retain attestation letters in a confidential and secure physical location currently.

### Proposed Solution

To ensure applicants accurately report data that represents all the pathway elements of their life cycle analysis at the time of application, the attestation letter is proposed to be submitted with the initial pathway application. The attestation letter is now termed the Fuel Pathway Applicant Attestation Letter.

Staff proposes to remove the requirement for mailing an original Attestation Letter. Staff proposes that submission of a scanned electronic copy would be acceptable. In addition, the requirement that the attestation letter be signed in blue ink has also been eliminated.

### Rationale Supporting Proposed Solution

This requirement will ensure applicants submit a complete application with all data and supporting information used to validate pathway CI.

Electronic copies provide for secure transmission and can be electronically archived. In addition, electronic copies of the fuel pathway applicant attestation letter are as binding

as a physical copy. The burden to retain paper copies in a secure physical location is also eliminated.

### **Section 95488.8(g)(1)(A).. Designation of Certain Feedstocks as Specified Source Feedstocks**

#### Description of Problem

Feedstocks derived from waste, residue, by-product and similar materials can be used to generate low CI fuels in the LCFS. In order to prevent the mischaracterization of fuels produced from such feedstocks, chain of custody evidence from the point of origin is needed to accurately document feedstock source, type and quantity for higher-risk feedstocks.

#### Proposed Solution

In order to provide transparency of the feedstock supply chain for higher risk feedstocks, staff proposes to create a designation called “specified source feedstocks.” This designation covers several waste, residue and by-product materials, as well as pipeline-injected biomethane from landfills. The designation also includes feedstocks for which the supplier applies for separate CARB recognition with site-specific data, as well as any other feedstocks that the Executive Officer designates Specified Source Feedstocks during the application review process. Such feedstocks would be subject to additional documentation requirements, including the requirement to maintain records demonstrating chain of custody along the supply chain and feedstock transfer documents. See proposed solution for section 95488.8(g)(1)(B) through (C) for details about chain of custody evidence.

#### Rationale Supporting Proposed Solution

Designating certain feedstocks as “specified source feedstocks” is necessary since these feedstocks carry a higher risk of mischaracterization or quantification errors. The potential for significant additional LCFS credits being generated from such feedstocks for the same finished fuel requires additional documentation for such feedstocks.

### **Section 95488.8(g)(1)(B) through (C). Chain-of-Custody Evidence and Feedstock Transfer Documents**

#### Description of Problem

Documentation is needed in order to facilitate transparency of supply chains for designated Specified Source Feedstocks, which enables verifiers and CARB to verify the source, type and quantity of the feedstock.

#### Proposed Solution

Staff proposes that fuel pathway applicants using specified source feedstocks must maintain records demonstrating chain of custody from the point of origin, which must be provided to the verifier and to the Executive Officer upon request. The fuel pathway applicant must maintain records of the type and quantity of feedstock obtained from each supplier, in addition to records used for material balance and energy balance

calculations. Fuel pathway applicants must maintain either, (1) delivery records showing shipments of feedstock type and quantity directly from the point of origin to the fuel production facility, or (2) information from material or energy balance systems which record the assignment of input characteristics to output quantities at relevant points along the feedstock supply chain between the point of origin and the fuel production facility. Access must also be granted to staff and verifiers to audit feedstock suppliers upon request. Feedstock transfer documents would need to include the transferor and recipient's contact information, the type and amount of feedstock transferred, and the transaction date. Staff proposes that joint applicants may assume responsibility for different parts of the chain-of-custody evidence, but must meet all of the documentation and access requirements of 95488.8(g)(1).

#### Rationale Supporting Proposed Solution

The required chain-of-custody documentation, including feedstock transfer documentation, is necessary to ensure that the source, type and quantity of the feedstock is verifiable and that the correct CIs are assigned to the fuel pathway application.

### **Section 95488.8(h). Renewable or low-CI process energy**

#### Description of Problem

The current regulation recognizes only directly supplied process energy to reduce CI, but the terms "direct" and "dedicated" could be clarified.

#### Proposed Solution

Staff proposes to clarify that 1) a renewable or low-CI source of electricity may also be grid-tied, but must be supplied behind the meter and may not be counted in any other program, and 2) any biogas or biomethane used as process energy must be physically supplied to the production facility. Additionally, an entity may not claim credit for producing more electricity than is used over a monthly balancing period.

#### Rational Supporting Proposed Solution

This revision clarifies the circumstances under which renewable process energy may be recognized for a reduced CI.

### **Section 95488.8(i)(1). Book-and-Claim Accounting for Renewable Electricity Used to Produce Hydrogen or Electricity Directly as a Vehicle Fuel**

#### Description of Problem

The CI of pathways for electricity supplied to vehicles, and hydrogen produced by electrolysis rely almost entirely on the source of the electricity, but no options exist under the current regulation for matching low-CI electricity to an EV or electrolysis load. For electric vehicles and hydrogen stations, opportunities for collocation of low-CI electric generation assets may be limited due to small land-area footprints. Additionally,

book-and-claim accounting (mass balance without regard to physical traceability) has been recognized for biomethane, but not electricity.

#### Proposed Solution

Staff is proposing to better define the contractual relationships that may be recognized to reduce carbon intensity for electricity supplied to vehicles and hydrogen production by electrolysis. These changes include:

- Extending the eligibility for renewable generation assets to include ownership or licensing of electricity from wind and solar facilities that are not collocated with the charging station.
- Recognizing that ownership or licensing may be demonstrated through the use of existing green tariff programs, programs that investor owned utilities already administer in California that obtain renewable electricity beyond RPS requirements.
- Recognizing that Community Choice Aggregators often offer their own green tariffs with renewable content beyond RPS requirements that may be eligible for LCFS pathway approval. These green tariffs could allow charging facilities and hydrogen producers to demonstrate procurement or utilization of renewable energy resources that reduce the carbon intensity for process electricity.
- Limiting the period over which electricity supplied can be matched to electricity dispensed to two quarters to facilitate accounting.

#### Rational Supporting Proposed Solution

While the LCFS has previously not allowed for book-and-claim accounting to be used for electricity, electric vehicle charging and hydrogen production through electrolysis represent unique cases due to the limited area to collocate renewable assets given that these fueling facilities are often located in urban environments. Furthermore, in the current regulation, all other fuel pathways are capable of reducing the carbon intensity of their feedstocks, but all electricity is assigned the average grid carbon intensity. To allow for these fuel pathways to further decarbonize, a book-and-claim accounting system will allow electric vehicles to use renewable electricity from renewable generation assets located in more efficient, practical or economical areas. Support for electricity decarbonization for electric vehicles allows for ultra-low carbon fuel pathways, which will help California better meet GHG emission reduction goals.

### **Section 95488.8(i)(2). Book-and-Claim Accounting for Pipeline Injected Biomethane Used as a Vehicle Fuel or to Produce Hydrogen**

#### Description of Problem

Although book-and-claim accounting has been allowed for pipeline injected biomethane, the regulation could more clearly define the conditions that must be met to recognize CI reductions using book-and-claim accounting.

### Proposed Solution

Staff proposes to clarify the definition and requirements for book-and-claim accounting for biomethane. In addition, staff proposes to limit to two quarters the period over which biomethane injected can be matched to gas withdrawn and used in California for use in vehicles or as a feedstock for hydrogen, to facilitate accounting.

### Rational Supporting Proposed Solution

This revision clarifies the circumstances and requirements for using book-and-claim for biomethane.

## **Section 95488.8(j)(1). Measurement Accuracy and Device Calibration**

### Description of Problem

Since staff is proposing that all site-specific inputs to fuel pathway applications must be verified, measurement accuracy and calibration requirements are needed in order for verifiers to ensure that measurement devices that log or record data for use in fuel pathway applications are functioning according to manufacturer specifications.

### Proposed Solution

Staff proposes to add minimum requirements for accuracy and calibration of measurement devices which log or record internal facility data for use in fuel pathway applications.

### Rationale Supporting Proposed Solution

Data recorded or logged by measurement devices are used to determine the CI of a fuel pathway and to demonstrate ongoing compliance with a previously certified CI. In order to accurately verify site-specific pathway inputs, verifiers must be able to ascertain that the measurement device that generated the data is appropriately calibrated and functioning as intended.

## **Section 95488.8(j)(2). Requests to Postpone Calibration**

### Description of Problem

Facilities operating continuously with infrequent outages may be unable to meet manufacturer-recommended calibration deadlines.

### Proposed Solution

In order to provide flexibility, staff proposes that continuously operating fuel production facilities that cannot meet the calibration requirements of 95488.8(j)(1) may submit written requests for postponement of calibration until the next scheduled maintenance outage. Staff proposes that requests for postponement of calibration be submitted at least 30 days in advance of the required calibration or inspection date and must include the items listed in 95488.8(j)(2)(B). Any additional documentation requested by the Executive Officer must be provided within 10 business days. Any requests to postpone calibration must be documented in the monitoring plan.



### Rationale Supporting Proposed Solution

Allowing for requests to postpone calibration provides continuously operating facilities the flexibility to better align calibration checks with planned unit shutdowns and minimizes down time required for calibration.

## **Section 95488.8(k). Missing Data**

### Description of Problem

In the event that required data is missing from an application or Fuel Pathway Report due to broken metering or recording devices, failure to comply with the calibration requirements, or a measurement device fails a field accuracy assessment, a process is needed for a verifier to determine whether the data are accurate or acceptable.

### Proposed Solution

Staff proposes that fuel pathway applicants or holders must demonstrate that the reported data are accurate within +/-5 percent. If the reported data meets this criteria, the data are acceptable for use in a fuel pathway application or Fuel Pathway Report, but the entity must describe when the measurement device will be brought into calibration. If the reported data does not meet this accuracy criteria, the entity must propose an alternate method of reporting the missing data, which is subject to approval by the Executive Officer. This provision would apply only to internal facility metering; no missing data is acceptable for transactions data, such as the quantities of feedstock purchased or fuel sold.

### Rationale Supporting Proposed Solution

The proposed process provides a flexible framework for managing situations in which the accuracy of data is called into question.

## **Section 95488.8(k)(3). Force Majeure Events**

### Description of Problem

Force majeure events, commonly understood to mean an event that could not be reasonably anticipated or controlled, may occur at a facility and significantly disrupt fuel production. A process for addressing data accuracy or temporary exceedance of certified CI in the case of a force majeure event does not exist in the current regulation.

### Proposed Solution

Staff proposes that fuel pathway applicants or holders must notify the Executive Officer in the case of a force majeure event that significantly impacts production. Force majeure situations would be handled on a case-by-case basis.

### Rationale Supporting Proposed Solution

Force majeure events, and their impacts on fuel production parameters and data collection, are by definition unpredictable, rendering the design of specific guidelines impractical.

## **SECTION 95488.9. SPECIAL CIRCUMSTANCES FOR FUEL PATHWAY APPLICATIONS.**

### **Section 95488.9(a). Substantiality Requirements**

#### Description of Problem

Substantiality requirements exist in the current regulation to provide an eligibility threshold to apply for Method 2A pathways. Staff is proposing to eliminate the Method 2A classification in the upcoming rulemaking, rendering this definition obsolete. However, the substantiality requirements are useful thresholds for other situations involving fuel pathway application eligibility.

#### Proposed Solution

Staff proposes to eliminate references to the Method 2A classification and to change the substantiality requirements to apply to two scenarios where staff seeks to limit the potential number of pathways.

The source-to-tank CI of the proposed pathway, meaning all of the steps involved in feedstock production and transport, and finished fuel production and transport, would need to meet a minimum CI reduction compared to the reference pathway.

#### Rationale Supporting Proposed Solution

The proposed substantiality requirements limit applicants from submitting multiple pathways with minimal differences in pathway CIs. It also limits fuels that could be certified under the Tier 1 framework requesting consideration under the Tier 2 framework by pathway applicants.

### **Section 95488.9(b). Temporary Fuel Pathway Request in AFP**

#### Description of Problem

The current regulation states that requests to use a Temporary pathway must be submitted using the Temporary FPC Request Form in the LRT-CBTS.

#### Proposed Solution

Staff proposes that Temporary pathway requests should be submitted through the AFP, and not LRT-CBTS.

#### Rationale Supporting Proposed Solution

The AFP is the intended system for the submission of fuel pathway applications and is better equipped to handle requests for Temporary pathways.

### **Section 95488.9(b)(1). Temporary Pathways**

#### Description of Problem

The current regulation does not specify whether an applicant may appeal the Executive Officer's decision to reject a petition to use a Temporary fuel pathway code.

### Proposed Solution

Staff proposes that the Executive Officer's decision regarding the rejection of a Temporary pathway request should be binding and not subject to appeal.

### Rationale Supporting Proposed Solution

The solution is proposed to clarify that the Executive Officer has the final authority to approve or deny a request to use a Temporary pathway.

## **Section 95488.9(b)(2). Use of a Temporary Pathway Beyond Two Quarters**

### Description of Problem

The current rule does not explicitly state that the Executive Officer may grant subsequent approvals after the first two quarter window.

### Proposed Solution

Staff proposes to explicitly state that the Executive Officer may consider a subsequent request for the use of a Temporary pathway for an additional two quarters.

### Rationale Supporting Proposed Solution

Delays in fuel pathway application review, validation and certification may require extensions of Temporary pathways beyond the period of two quarters for which these pathways may be initially approved. Adding this provision would provide flexibility to the Executive Officer to accommodate delays in pathway certification and facilitate the reporting of fuel transactions. The Executive Officer would evaluate the circumstances for an extension of the use of a Temporary pathway.

## **Section 95488.9(b)(4). New Temporary Pathways**

### Description of Problem

The current regulation does not contain a provision allowing for the creation of new Temporary fuel pathways. The Executive Officer is therefore unable to certify a CI for feedstock-fuel combinations not currently in the Temporary pathways table.

### Proposed Solution

Staff proposes to allow the Executive Officer to certify new Temporary pathways. Staff proposes that any new proposed Temporary pathway CI value would be posted for public comment using the same process as the annual update to the Lookup Table pathway California Average Grid Electricity. Upon certification, a new Temporary pathway CI value would be available for reporting in the quarter in which it is certified.

### Rationale Supporting Proposed Solution

The proposed solution provides flexibility to account for feedstock-fuel combinations that currently do not exist in the LCFS, and may improve accuracy in accounting for the GHG benefits of new pathways.

**Section 95488.9(b). Table 8: Revisions to the Temporary Pathways Table**

The following table describes each proposed change to the table of Temporary Pathways (Table 8 in the proposed amendments, Table 7 in the current regulation). The temporary CIs have been determined using the most conservative pathway certified with that feedstock-fuel combination, increased by an additional 5 percent and rounded up to the nearest five CI points when applicable, to ensure the pathway CIs are conservative with respect to claimed GHG reductions.

**Table III-2: Specific Purpose and Rationale for Proposed Changes to Table 8 Temporary Pathways for Fuels with Indeterminate CIs**

Description of problem	Proposed Solution – Modification to Table 8.	Rationale
Sugar cane and molasses ethanol pathway CIs do not vary significantly; in addition, sugar beets are excluded in the current rule.	Change “Sugar Cane and Molasses” to “Any Sugar Feedstock.”	This change would broaden the scope of the pathway to include all sugar-derived feedstocks.
Corn stover is the only cellulosic feedstock listed in the temporary pathway table, potentially excluding other cellulosic feedstocks.	Change “Corn Stover” to “Any Cellulosic Biomass.”	This change would broaden the scope of the temporary pathway to include other cellulosic feedstocks if used in the production of transportation fuels.
Separate temporary CIs for biodiesel and renewable diesel requires different CIs for these two types of fuel pathways, although conservative CIs for temporary pathways should allow for the same CIs to be used for both types of fuel pathways.	Combine biodiesel and renewable diesel categories in the Table to “Biomass-based diesel.”	This change would simplify the assignment of Temporary pathways for biodiesel and renewable diesel pathway applicants.
Biodiesel and renewable diesel from used cooking oil is currently excluded from the Temporary Pathways Table.	Change “Any feedstock derived from animal fats” to “Fats/Oils/Grease Residues.”	Provides flexibility to include additional feedstocks used in the production of such fuels.
Palm oil is a high CI feedstock which could be classified under “plant oils” if not explicitly	Add the phrase, “excluding palm oil”, to the existing temporary classification for “Any	The proposed change will ensure that fuel produced from palm biodiesel cannot request

excluded from this pathway.	feedstock derived from plant oils.”	the ‘plant oils’ temporary CI pathway.
Biomethane from municipal wastewater sludge is not included in the temporary table, potentially limiting credit generation from such pathways if certification of pathway applications are delayed.	Add CNG, LNG and L-CNG pathways for biomethane from municipal wastewater sludge.	Allows such pathway applicants to generate credits with conservative pathway CIs.
Biomethane from dairy or food/green waste is not included in the current table, potentially limiting credit generation from such pathways if certification of pathway applications are delayed.	Add CNG, LNG and L-CNG pathways for biomethane from dairy or food/green waste.	Allows such pathway applicants to generate credits with conservative pathway CIs.
The proposed inclusion of a Fossil CNG pathway in the Lookup Table negates the need to include a temporary pathway for this fuel.	Delete the temporary pathway for fossil CNG.	This change removes redundancy from the table of temporary pathways.
The grid electricity pathway in the Lookup Table negates the need to include a temporary pathway for this fuel.	Delete the temporary pathway for grid electricity.	This change removes redundancy from the table of temporary pathways.
Four hydrogen pathways are currently available in the temporary pathways table. Including all of these pathways is inconsistent with the purpose of the temporary fuel pathway, to offer a conservative CI value from an available suite of feedstock and production processes.	Delete all temporary pathways for hydrogen except for hydrogen produced by centralized reforming of fossil LNG.	This pathway is the most conservative hydrogen pathway and is appropriate for use in the temporary pathways table.

## **Section 95488.9(c)(1) through (2). Application Process and Verification Schedule for Provisional Pathways**

### Description of Problem

The application process for provisional pathways under the current regulation requires fuel pathway applicants to submit receipts, inputs and other pathway input data used to calculate the CI of the fuel. The proposed mandatory verification program transfers verification of invoices, receipts and other facility and pathway data to a third-party verifier. These provisions need to be made consistent with the proposed new verification process.

### Proposed Solution

Staff proposes to assign the same validation and verification requirements to provisional pathways that all conventional pathways are subject to under 95500. Under the proposed requirements, all provisional pathways would be required to obtain validation after submitting a fuel pathway application.

### Rationale Supporting Proposed Solution

Inclusion of mandatory verification requirements for fuel pathway applications being conducted by third-party verifiers requires modifications to the current pathway certification process.

## **Section 95488.9(c)(3) through (4). Adjusting CI and Credit Balance and Removal of Provisional Status**

### Description of Problem

For provisional pathways, the Executive Officer currently has the authority to periodically adjust pathway CIs based on quarterly operational data submitted to CARB until the full 24 months of operational data has been submitted. In addition, the Executive Officer has the authority to adjust credits if the operational CI (intermediate or final CI) is higher than the originally certified CI. This approach needs modification to align with the proposed system for third-party verification.

### Proposed Solution

Staff proposes to remove the requirement to submit operational data to CARB every three months. Instead, the CI would be checked during annual verification, at which time the CI could be revised according to the plant's actual operational CI based on a positive or qualified positive verification statement. If, at verification after 24 months of operational data have been recorded, the CI is determined to be higher than provisionally-certified CI, credits would be subject to adjustment for the entire period from initial validation to post-24-month verification. If the CI at verification after 24 months of operational data is lower than the CI at validation, the CI would be updated to the lower value and used moving forward. The removal of provisional status would occur after a positive verification and subsequent certification, which would occur after completing 24 months of commercial operation.

### Rationale Supporting Proposed Solution

The proposed annual verification requirements are an effective replacement to quarterly data submission, because credits are subject to adjustment after each verification of the provisional fuel pathway. Potential for credit adjustment from the point of removal of provisional status to initial validation of the pathway is necessary to ensure the environmental integrity of the program. The proposed actions for adjusting the verified operational CI are consistent with treatment of non-provisional pathways.

### **Section 95488.9(d). Substitute Pathways for Reporting Exports and Other Transaction Types**

#### Description of Problem

At the time of reporting fuel in the LRT-CBTS, the fuel pathway may not be known or available to the reporting entity. For example, if the entity is exporting a blended fuel or fuel that was purchased without obligation then the entity may not have the correct pathway available for reporting in the LRT-CBTS.

#### Proposed Solution

When the actual pathway is not known or not available, staff is proposing to provide Substitute Pathways for reporting only the following transactions:

- (A) Sold without obligation
- (B) Purchased without obligation
- (C) Export
- (D) Loss of inventory
- (E) Not used for transportation

CI values for Substitute Pathways will be the volume-weighted average CI for the fuel calculated from the data reported in the prior year. The Substitute Pathways and CI values will be published on CARB's website and will be updated as and when required. Along with the Substitute Pathway Code and CI, CARB will also provide any other default values, such as an "unknown production facility" identifier, that would be required for reporting using Substitute Pathways.

### Rationale Supporting Proposed Solution

This will provide clear guidance for reporting fuels when the actual FPC is either unknown or unavailable for reporting in LRT-CBTS.

### **Section 95488.9(e). Design-based Pathways**

#### Description of Problem

Standard pathway applications are required to provide 24 months of operational data and provisional pathways require a minimum of three months of operational data to be eligible for certification. Fuel pathways for engineered facilities that include design data but do not include commercial production are not eligible to be considered under the current rule. This limitation may hamper the development and financing of nascent,

innovative fuel technologies that could benefit from CARB recognition of potential carbon intensity reductions.

#### Proposed Solution

Staff is proposing to create a special provision to allow the Executive Officer to evaluate fuel pathways for fully engineered and designed facilities that have not yet commenced commercial production. Staff proposes to designate such pathways as “Design-based pathways.” Applications for Design-based pathways would be similar to Tier 2 pathways as detailed in section 95488.7.

Staff proposes that Design-based pathways would be exempt from validation but would not be eligible to report fuel volumes (or claim credits) under the pathway. Reporting would require submission and certification of a provisional pathway that would include, at a minimum, three months of operational data.

#### Rationale Supporting Proposed Solution

The LCFS program seeks to incentivize the development of next-generation low-CI fuels. Investors in promising fuel production technologies seek investor support to provide long-term financing for planning, designing, building and commencing operation. Posting such Design-based pathways with a CI score based on considerations by the Executive Officer may help facilitate investments in such projects, potentially ensuring commercialization of novel fuel production technologies.

### **SECTION 95488.10. MAINTAINING FUEL PATHWAYS.**

#### **Section 95488.10(a)(1). Annual Upload of Simplified CI Calculator or CA-GREET3.0 Model**

##### Description of Problem

The current rule relies heavily on the initial CI approval by the Executive Officer to assess pathway holders’ CI performance. However, the rule also requires that pathway holders stay below their certified CI.

##### Proposed Solution

Staff proposes a requirement for annual reporting of operational data to ensure conformance with the certified CI. The annual Fuel Pathway Reports would include operational data covering the most recent two calendar years, allowing actual CI performance to be checked against the certified CI values.

Staff proposes that the Simplified CI Calculator could be used as a template for this annual report for Tier 1 pathways. For Tier 2 pathways, the CA-GREET3.0 model and the list of site-specific inputs developed and approved during certification would be required to demonstrate continuing compliance.



### Rationale Supporting Proposed Solution

In order to facilitate third-party verification and demonstrate ongoing compliance with the certified CI, verifiers and staff must have access to the most current 24 months of operational data (used to calculate the ongoing fuel pathway CI), available through the annual Fuel Pathway Report.

### **Section 95488.10(a)(2). Annual Upload of Invoices or Metering Records**

#### Description of Problem

Since the proposed third-party verification requirements exempt entities using Lookup Table pathways from review of CI data, invoices and metering records to substantiate renewable energy quantities must be submitted to demonstrate that pathways are in compliance.

#### Proposed Solution

For such pathways, staff proposes requiring submittal of an annual Fuel Pathway Report containing invoices or metering records substantiating the quantity and source of renewable energy inputs to the pathway.

#### Rationale Supporting Proposed Solution

See the rationale for requiring documentation for renewable inputs in 95488.5(b)(1) and (2). Renewable energy inputs should be regularly checked to ensure ongoing compliance and the environmental integrity of the program.

### **Section 95488.10(a)(3). Requirement to Submit Attestation Regarding Renewable Attributes**

#### Description of Problem

Staff is proposing that fuel pathway applicants may use indirect accounting for RNG used as a transportation fuel or for the production of hydrogen fuel and submit the attestation listed in section 95488.8(i)(2)(C). A timeline for submission of this attestation by fuel pathway holders is needed.

#### Proposed Solution

Staff proposes that fuel pathway holders must submit this attestation in accordance with the due date for the annual Fuel Pathway Report (March 31 of each calendar year).

#### Rationale Supporting Proposed Solution

This proposed requirement clarifies the responsibilities of fuel pathway holders specified in section 95488.8(i)(2)(C).

## **Section 95488.10(a)(4). Annual Upload of Supplementary Documentation and All Other Required Data or Documentation**

### Description of Problem

Supplemental information is needed to verify ongoing compliance of the certified CI (see also the problem, solution and rationale for section 95488.6(a)(2) for more on the role of supplemental information). In addition, required documentation in the pathway summary operating conditions may also be necessary to verify compliance with the certified CI.

### Proposed Solution

Staff proposes that fuel pathway holders may need to include supplementary information and required documentation if requested by the Executive Officer, as part of the annual Fuel Pathway Report.

### Rationale Supporting Proposed Solution

This requirement provides flexibility to the Executive Officer to request any information needed to verify ongoing compliance with the certified CI. The documentation is only required on an as-needed basis.

## **Section 95488.10(a)(5). Verified CI Reductions**

### Description of Problem

Currently, fuel pathway holders do not have the opportunity to reduce their CI without reapplying for a new pathway. Improvements to CI from process innovations completed after certification of a fuel pathway cannot be credited without reapplying for a new pathway that changes the CI to account for the improvements.

### Proposed Solution

In the event that an operational CI is found to be lower than the previously certified CI, and a positive or qualified positive verification statement is issued for this period, staff proposes that the fuel pathway holder may elect to keep the originally certified CI, or may request to adopt the verified operational CI for future reporting. Pathway holders would also have the option to add a margin of safety to the pathway CI. Pathway holders who choose to update CI must attest that the new CI can be maintained.

### Rationale Supporting Proposed Solution

The LCFS encourages fuel pathway holders to improve the efficiency of their operations or otherwise reduce the carbon intensity of their pathway on an ongoing basis. Providing an option to adopt lower CIs based on demonstrated performance may incentivize innovation at fuel production facilities.

### **Section 95488.10(a)(6). Verified CI Increases**

#### Description of Problem

The current rule makes it clear that the certified CI is a cap, and that any exceedance of the certified CI constitutes non-compliance with appropriate penalties.

#### Proposed Solution

The proposed rule does not change the treatment of the certified CI value as a cap but clarifies that if the verified operational CI exceeds the certified CI, the fuel pathway holder would be out of compliance with the regulation and subject to investigation and possible enforcement action.

#### Rationale Supporting Proposed Solution

The proposed addition simply clarifies that the verification process does not affect the current regulatory practice of treating the certified CI as a limit or cap.

### **Section 95488.10(b). Requirement to Complete and Retain a Monitoring Plan**

#### Description of Problem

See Description of Problem for 95491.1(c).

#### Proposed Solution

See Proposed Solution for 95491.1(c).

#### Rationale Supporting Proposed Solution

See Rationale Supporting Proposed Solution for 95491.1(c).

### **Section 95488.10(c). Verification Requirement and Deadline**

#### Description of Problem

Detailed instructions are needed regarding the requirements of fuel pathway holders to complete verification on an annual basis.

#### Proposed Solution

Staff proposes that in order to maintain a valid fuel pathway code, a positive or qualified positive verification statement must be received by the Executive Officer annually in accordance with the verification schedule described in section 95500. Staff proposes that an adverse verification statement would result in investigation by the Executive Officer. The fuel pathway holder is responsible for ensuring that the verification statement is submitted on time.

#### Rationale Supporting Proposed Solution

Verification of fuel pathways is essential to the integrity of the program and the schedule and requirements of the proposed third-party verification program must be upheld in order to remain in compliance with the subarticle. Staff proposes that the fuel pathway

applicant is responsible for the submission of a positive or qualified positive verification statement to the Executive Officer, because they are the entity responsible for submitting accurate data to the verifier.

## **SECTION 95489. PROVISIONS FOR PETROLEUM-BASED FUELS.**

### **Section 95489. Table 8: Carbon Intensity Lookup Table for Crude Oil Production and Transport (Deleted and Replaced)**

#### Description of Problem

In the current regulation, Table 8 provides the carbon intensity for each type of crude, determined using OPGEE version 1.1, adopted in 2015, and the current regulation requires these CI values to be considered on a three-year cycle.

#### Proposed Solution

Staff is proposing to delete this section in its entirety and replace Table 8 with Table 9 under 95489(c). All individual crude CI values in Table 9 are updated using OPGEE v2.0 and oil field operational data from the year 2015, which is the latest year for which a complete set of data for many of the crudes is available. The 2010 Baseline Crude Average CI value is updated using OPGEE v2.0 and oil field operational data for the year 2010, which is the baseline year for the LCFS regulation. CI values are estimated using the methodology described in Appendix I.

#### Rationale Supporting Proposed Solution

This update fulfills the requirement of the current regulation to consider the following items on a three-year cycle through proposed amendments to the regulation:

- Revisions to the Oil Production Greenhouse Gas Emissions Estimator (OPGEE) model,
- Addition of crudes to the Carbon Intensity Lookup Table for Crude Oil Production and Transport (Table 9 in the proposed regulation order, Table 8 in the current regulation), and
- Updates to all carbon intensity values in proposed Table 9.

### **Section 95489(a). Outline**

#### Description of Problem

In the current regulation, section 95489(a) provides an outline for the section. However, an outline is not provided for any other section of the regulation.

#### Proposed Solution

Staff is proposing to delete this subsection in its entirety.

#### Rationale Supporting Proposed Solution

The deletion of this subsection ensures the consistency in presentation of the regulation language.

## **Section 95489(a). Deficit Calculation for CARBOB or Diesel Fuel.**

### Description of Problem

This section provides the base and incremental deficit calculations for CARBOB and diesel fuel. Incremental deficits are incurred by refineries if the Three-year California Crude Average carbon intensity exceeds the California Baseline Crude Average carbon intensity by more than 0.10 gCO<sub>2</sub>e/MJ. The equations used to calculate both the Three-year California Crude Average carbon intensity and the California Baseline Crude Average carbon intensity are dependent upon the results of crude life cycle modeling using the OPGEE model. When the OPGEE model and the Carbon Intensity Lookup Table for Crude Oil Production and Transport are updated, these equations must also be updated.

### Proposed Solution

Update the equations used to calculate both the Three-year California Crude Average carbon intensity and the California Baseline Crude Average carbon intensity to be consistent with the revised OPGEE model and the Carbon Intensity Lookup Table for Crude Oil Production and Transport.

### Rationale Supporting Proposed Solution

This section is necessary to specify and clearly describe the equations to be used to calculate both base and incremental deficits for CARBOB and diesel fuels. In order to maintain consistency, the equations used to calculate both the Three-year California Crude Average carbon intensity and the California Baseline Crude Average carbon intensity must be updated when the OPGEE model and the Carbon Intensity Lookup Table for Crude Oil Production and Transport are updated.

## **Section 95489(b)(3)(B). Annual Crude Average Carbon Intensity Value**

### Description of Problem

The regulation describes the process for calculating the Annual Crude Average carbon intensity value using marketable crude volumes reported by California refineries. Since staff is proposing the addition of a third-party verification system, an update is needed to ensure that the Annual Crude Average will be based on verified marketable crude volumes.

### Proposed Solution

Staff is proposing to update the process by including third-party verification requirements for marketable crude volumes and delaying the date for finalizing the Annual Crude Average CI until verification reports are received.

### Rationale Supporting Proposed Solution

An accurate calculation of the Annual Crude Average CI is dependent on accurate reporting of marketable crude name volumes by refineries. To ensure accurate reporting of crude volumes, staff is proposing to include verification of marketable crude

volumes reported by refineries. The Annual Crude Average will not be finalized until positive or qualified positive verification reports for crude volumes are received from each refinery.

**Section 95489(c). Table 9: Carbon Intensity Lookup Table for Crude Oil Production and Transport**

*(see the problem, solution, and rationale for section 95489. Table 8, above.)*

**Section 95489(c). Credits for Producing Crudes using Innovative Methods**

Description of Problem

The current innovative crude provision allows crude oil producers to work with third-party suppliers for solar steam or renewable electricity, but restricts credit generation to the crude producer. Stakeholders have suggested that this unnecessarily restricts contractual arrangements for these projects, thereby preventing some projects from being implemented.

Proposed Solution

Staff is proposing to allow the third-party joint-applicants to opt into the program and receive credit for the projects upon contractual agreement with the crude oil producer.

Rationale Supporting Proposed Solution

Allowing third-party joint-applicants to opt into the LCFS will add flexibility in contractual arrangements between the third-party supplier and the crude oil producer.

**Section 95489(c)(1)(A)2. Innovative methods including CCS**

Description of Problem

The list of technologies which are eligible for credit generation under the innovative crude provisions includes CCS, which is incorrectly listed as carbon capture and storage, rather than (geologic) sequestration.

Proposed Solution

Staff is proposing to replace “storage” with “sequestration.”

Rationale Supporting Proposed Solution

This is a minor change to correct an error in terminology, without any material impact on requirements. This change ensures the consistency in presentation of the regulation language.

**Section 95489(c)(1)(B). Retroactive credits for innovative crude**

Description of Problem

The current innovative crude provision allows electricity and heat generation projects to generate credits subject to a number of deadlines, all of which have passed.

This provision to generate credits retroactively was never used. This section is no longer needed.

#### Proposed Solution

Staff is proposing to remove this subsection.

#### Rationale Supporting Proposed Solution

The removal of text, which is irrelevant, expired, unused, and no longer applicable assists in keeping the text clear and up to date.

### **Section 95489(c)(1)(D). Crude oil producer registration**

#### Description of Problem

Applications for innovative crude production method projects must be submitted to CARB by the crude oil producer who implements the innovative project. In some cases, a third party may be involved in these projects, such as when solar or wind electricity or solar steam is generated by the third party and sold to the crude oil producer, or when the crude oil producer captures CO<sub>2</sub> and transfers the CO<sub>2</sub> to a third party who then sequesters it. In these situations, the third party must be a joint applicant on the project.

The current regulation, however, only allows the crude oil producer to register under the LCFS and earn credits. The third party is not allowed to be a credit generator. Stakeholders have requested more flexibility in the regulation language to allow the joint applicant to be the credit generator when financial terms of the project make this a better option.

#### Proposed Solution

The crude oil producer will remain first in line to generate LCFS credits for innovative crude projects. However, the crude producer may elect to transfer the right to generate LCFS credits to the joint applicant. This transfer must be done through written agreement between the crude producer and the joint applicant.

#### Rationale Supporting Proposed Solution

The proposed solution provides flexibility for the joint applicant to receive LCFS credit. The proposed solution designates the crude producer as first in line to receive the credit unless a written agreement transfers this right to the joint applicant. This orderly progression prevents double claiming of credits by both the crude producer and joint applicant.

### **Section 95489(c)(1)(F). Credit Calculation for Solar Steam Projects**

#### Description of Problem

The existing regulation provides credit calculations for solar steam produced at three steam quality ranges: 55 to 65 percent, 65 to 75 percent, and greater than 75 percent. That system does not differentiate between steam above 75 percent.

### Proposed Solution

Staff is proposing to update the calculation of credits for producing crude oil with solar steam by adding two additional ranges: 85 to 95 percent and greater than 95 percent. Staff is also proposing to revise the avoided emissions values for all steam quality ranges using the revised OPGEEv2.0 model.

### Rationale Supporting Proposed Solution

Revising the avoided emissions values and including two additional ranges will more accurately represent enthalpy and emissions per barrel for some thermally enhanced oil recovery operations.

## **Section 95489(c)(1)(G). Prohibition on double-counting**

### Description of Problem

The existing regulation provides no limitations on solar and wind electricity and solar steam or heat generation that generates LCFS credits. By not including limitations, projects might claim renewable energy certificates or other environmental attributes in multiple programs.

### Proposed Solution

Staff is proposing to add language to prohibit projects from claiming renewable energy certificates or other environmental attributes recognized or credited by any other jurisdiction or regulatory program.

### Rationale Supporting Proposed Solution

These limitations will prevent double-counting of the GHG benefits of these projects, ensuring the environmental integrity of the program.

## **Section 95489(c)(2)(E). Requirements for reference lists**

### Description of Problem

The existing regulation lists the requirements for the transmittal letter from the applicant attesting to the veracity of the information in the application packet.

### Proposed Solution

Staff is proposing to reference section 95488.8(a)(3)(A) through (D), which already includes the requirements of the transmittal letter.

### Rationale Supporting Proposed Solution

This change will simplify the regulation.

## **Section 95489(c)(2)(F). Transmittal letter**

### Description of Problem

The existing regulation lists the requirements for the transmittal letter from the applicant attesting to the veracity of the information in the application packet.



Proposed Solution

Staff is proposing to reference section 95488.8(a)(3)(A) through (D), which already includes the requirements of the transmittal letter.

Rationale Supporting Proposed Solution

This change will simplify the regulation.

**Section 95489(c)(2)(G). Confidential Business Information**

Description of Problem

The existing regulation lists the requirements for submitting documents with confidential business information.

Proposed Solution

Staff is proposing to reference section 95488.8(c), which already includes the requirements for submitting documents with confidential business information.

Rationale Supporting Proposed Solution

This change will simplify the regulation.

**Section 95489(c)(2)(H). Submitting applications**

Description of Problem

The existing regulation lists the requirements for submitting an application.

Proposed Solution

Staff is proposing that the applications be submitted electronically via the AFP.

Rationale Supporting Proposed Solution

This change will simplify the regulation.

**Section 95489(c)(4). Recordkeeping and Reporting Requirements for Innovative Crude Projects**

Description of Problem

Requirements for reporting are not specified for solar steam, wind and solar electricity projects under the current innovative crude provision.

Proposed Solution

First, staff is proposing to require records to be submitted to the Executive Officer during the quarterly reporting period specified in section 95491(a)(1) instead of within 20 days of a written request received from the Executive Officer.

Second, staff is proposing to add detailed quarterly "Project Report" requirements for solar or wind electricity and solar steam projects under the innovative crude provision.

Staff is proposing to add the following reporting requirements for solar or wind electricity projects:

- Metered data on solar or wind electricity consumed for crude oil production at the oil field during the quarter (kWh);
- Metered data on total electricity consumed for crude oil production at the oil field during the quarter (kWh); and
- An attestation letter stating that all solar or wind electricity was supplied directly for crude oil production at the oil field and that the solar/wind electricity reported for generating LCFS credit did not produce renewable energy certificates or other renewable attributes recognized or credited by any other jurisdiction or regulatory program.

Similarly, staff is proposing to add the following reporting requirements for solar steam projects:

- Metered data on solar steam consumed for crude oil production at the oil field during the quarter (barrels cold water equivalent);
- Metered data on total steam consumed for crude oil production at the oil field during the quarter (barrels cold water equivalent);
- Volume-weighted average steam quality for solar steam consumed for crude oil production at the oil field during the quarter; and
- An attestation letter stating that all solar steam was supplied directly for crude oil production at the oil field and that the solar steam reported for generating LCFS credit did not produce renewable energy certificates or other renewable attributes recognized or credited by any other jurisdiction or regulatory program.

Thirdly, staff is proposing that crude oil that is wholly refined in California not be required to report crude blend names and the volume fraction that the innovative crude contributes to the blend.

Finally, staff is proposing to require documentation showing that the innovative crude was supplied to California refineries and the volume of innovative crude supplied to each California refinery.

#### Rationale Supporting Proposed Solution

Detailed recordkeeping and reporting requirements are necessary to provide guidance for facilities producing innovative crude, to allow for compliance with requirements to be evaluated and verified, and to allow for accurate calculation of credits to be awarded.

Innovative crude credit is only awarded to that portion of crude that is supplied to California refineries. Therefore, it is required that evidence be provided showing the volume of crude supplied to California refineries. For crudes that are not wholly refined in California, this evidence includes detailed information on crude blend names and volume fraction of innovative crude within a given blend. This information will allow

third-parties to verify the volumes of innovative crude supplied to California refineries and for staff to accurately calculate the appropriate quantity of credits to award.

### **Section 95489(c)(5). Credit Issuance**

#### Description of Problem

Since staff is proposing the addition of a third-party verification system, an update is needed to ensure that all innovative crude projects will be subject to verification.

#### Proposed Solution

Staff is proposing to add third-party verification of reported data to the requirements for credit generation. All innovative crude projects will be subject to verification of reported data from the applicable Project Reports prior to the issuance of credits. Verification (and thus credit issuance) can be scheduled quarterly or annually, at the option of the Project Operator.

#### Rationale Supporting Proposed Solution

Subjecting innovative crude projects to verification prior to the issuance of credits will ensure that the credits being reported for these projects are valid. Because the cost of verification is covered by the project operator, flexibility to determine the frequency of verification and credit generation will allow projects spanning a wide range of credit generation value to participate. Small credit generators may elect for less frequent verification and credit generation to manage the overall cost of verification relative to the value of the credits generated. Conversely, large credit generators may elect to monetize the credits more frequently, especially if the project required large up front capital costs.

### **Section 95489(d)(1)(A). Modified Nelson Complexity Score**

#### Description of the Problem

The Modified Nelson Complexity Score is used to determine eligibility for Low-Complexity/Low-Energy-Use (LC/LEU) Refinery Credits. The Modified Nelson Complexity score depends on the refining process unit capacity, which is expressed in different units (e.g. barrels per day) for different processing units. The current provision only mentions barrels per day, which is not applicable to hydrogen production and sulfur extraction.

#### Proposed Solution

Staff is proposing to specify the units for hydrogen production and sulfur extraction in Table 10.

#### Rationale Supporting the Proposed Solution

By specifying the proper units for hydrogen and sulfur extraction, it helps refineries accurately estimate the Modified Nelson Complexity score and establish their eligibility for LC/LEU Refinery Credits.

## **Section 95489(d)(2). LC/LEU Reporting Requirements**

### Description of the Problem

Since LC/LEU refineries may produce CARBOB and diesel from sources other than crude oil such as petroleum intermediates and transmix and credits are awarded only to CARBOB and diesel produced from crude oil, the actual volumes of CARBOB and diesel produced from crude oil need to be reported and verified.

### Proposed Solution

Staff is proposing to add a clear reporting and verification requirement for CARBOB and diesel produced from crude oil. Staff is proposing an annual report with third-party verification for produced volumes of CARBOB and diesel from crude oil. Staff is proposing that the annual report must be submitted by March 31 and the verification statement is due August 31<sup>st</sup>.

### Rationale Supporting the Proposed Solution

The reporting and verification requirement enables accurate calculations of LC/LEU Refinery Credits.

## **Section 95489(d)(4). LC/LEU Application Contents and Submittal**

### Description of the Problem

The current regulation provision lacks a thorough description of application requirements.

### Proposed Solution

Staff is proposing to describe the application content and submittal process for Low-Complexity/Low-Energy-Use Refinery Credit applications. Staff is proposing that application package must include summary materials consisting of a description of refinery process units and capacity, engineering diagrams/process diagrams, and energy use. Staff is proposing that refinery operators must submit a transmittal letter attesting to the veracity of the information in the application packet, and a list of references used in credit calculations. Also, if there is a material change to a refinery, the refinery operator must notify the Executive Officer in writing within 30 business days after the material change has occurred, and the previously-approved application shall become invalid 30 business days after the material change has occurred.

### Rationale Supporting the Proposed Solution

The added clarification helps refineries better understand the application process and submittal materials required to produce a complete application package.

## **Section 95489(d)(5). LC/LEU Credit Issuance**

### Description of the Problem

Since staff is proposing the addition of a third-party verification system, updates are needed to integrate verification requirements and timing of credit issuance.

### Proposed Solution

Staff is proposing to clarify the timing of credit issuance by stating the credits for the prior year will be awarded annually after annual verification of energy use, and CARBOB and diesel volumes. Staff is proposing verification of produced volumes of CARBOB and diesel under annual verification of quarterly fuel transactions

### Rationale Supporting the Proposed Solution

The added clarification helps refineries better understand the crediting process, timing, and verification requirements.

## **95489(d)(4). Refinery-Specific Incremental Deficit Calculations (removed)**

### Description of the Problem

Low-Complexity/Low-Energy-Use refineries had the option to elect to use a refinery-specific incremental deficit calculation by January 31, 2016. No refineries elected to use this provision and as a result, this provision has become defunct.

### Proposed Solution

Staff proposes to eliminate this provision.

### Rationale Supporting the Proposed Solution

The rationale for eliminating the provision is that it has expired and was not utilized.

## **Section 95489(e). Refinery Investment Credit Pilot Program (RICPP)**

The Refinery Investment Credit Pilot Program (RICPP) in the current regulation allows refineries to generate credits for projects that reduce refinery greenhouse gas (GHG) emissions by at least 0.1 gCO<sub>2</sub>e/MJ, calculated based on pre- and post-project GHG emissions at the refinery level

Staff is proposing several changes to the refinery investment credit pilot program to make the credit calculation workable, to avoid over or under crediting due to refinery-wide emissions changes, and to improve the clarity and overall structure of the RICPP. The problem, proposed solution and the rationale for the RICPP-related changes are described below.

### **Section 95489(e)(1). RICPP General Requirements**

#### Description of the Problem

Since staff is proposing to move from refinery-wide GHG accounting to project level GHG accounting, there is need to establish a new threshold for generating credits which is simpler and equitable to all types of refineries as part of the general requirements. The existing general requirements could also be further clarified as to which refinery investment projects are eligible and how proration must be carried out. Moreover, as discussed in the description of the problem for section 95485(d), the current regulation's

restrictions on credit generation and tradability could limit the incentive signal for potential GHG reductions from innovative refinery projects.

### Proposed Solution

In order to make the threshold-based eligibility equitable to all refineries and easy to estimate, staff is proposing a minimum life cycle GHG reduction of 1 percent compared to the pre-project on-site refinery level GHG emissions.

Staff is proposing to include a list of eligible projects that includes process improvements, carbon capture and sequestration, renewable electricity, and fossil fuel displacement by use of renewable fuels or electrification.

Staff is proposing proration of credits for a period during which the project remains nonoperational. Similarly, staff is proposing proration of credits if the hydrogen production facility that captures CO<sub>2</sub> does not supply all of its hydrogen to the applicant refiner.

Finally, staff is proposing to remove the tradability restriction for all eligible projects to encourage investments in innovative projects that result in significant reductions in the carbon intensities of CARBOB and diesel. In conjunction with the proposed solution for section 95485(d), above, staff is proposing to remove the 20% limit on credits generated from innovative projects while revising the limit downward to 5% for process improvement projects. The proposed amendment would sunset the eligibility of credits generated from process improvement projects after January 1, 2025.

### Rationale Supporting the Proposed Solution

Refineries constitute a significant source of GHG emissions in California and elsewhere. GHG emissions from California refineries were 67 million metric tons (MMT) in 2015. Several avenues of GHG reductions exist for refineries including renewable electricity use, fuel switching, and carbon capture and sequestration. For example, a preliminary staff analysis found that implementation of carbon capture project at steam methane reforming (SMR) units in California refineries has the potential to capture 2 MMT of CO<sub>2</sub> per year, or more. By adding a list of eligible projects that includes innovative projects with significant GHG reduction potential, appreciable GHG reductions from the refining sector can be realized.

By removing the credit generation and tradability restrictions on the credits generated from innovative projects, staff intends to provide a strong long-term signal for transformative refinery investment projects to align the provision to more effectively achieve the goals of the LCFS. Similarly, the 5% limit on credit generation for process improvement projects is intended to encourage more significant innovations at refineries.

Improvements made in the general requirements, such as the 1 percent GHG reduction threshold, will simplify credit calculations and eligibility determination. Proration of credits ensures accuracy in assessing GHG reductions.

## **Section 95489(e)(2). Calculation of Refinery Investment Credits**

### Description of the Problem

The current credit calculation method requires estimations of refinery-wide GHG emissions. Hence, GHG reductions from any specific project may not be reflected in refinery-wide GHG emissions changes due to the scale of projects being potentially orders of magnitude smaller than total refinery emissions. Consequently, the current calculation method may either overestimate or underestimate the amount of credits associated with a refinery GHG emissions reduction project as a result of year-to-year variations in refinery GHG emissions unrelated to the RICPP project. The method needs to be workable and simpler to encourage GHG reductions in refineries.

### Proposed Solution

Staff is proposing to make the following changes to the calculation methods:

- Define project system boundaries at the process unit level rather than the refinery level,
- Accounting GHG emissions at the project level before and after project implementation,
- Make credit calculations simpler by reducing the number of calculation steps, and
- Include a proration factor to prorate credits based on the volumes of CARBOB and diesel sold or offered for sale in California.

### Rationale Supporting the Proposed Solution

The revised calculation method makes credit estimation workable, avoids over or under crediting due to refinery-wide emissions changes, and improves the clarity and overall structure of the RICPP. The improved framework is expected to encourage investments in refinery projects thereby contributing to GHG reductions.

## **Section 95489(e)(5). Credit Issuance**

*(see the problem, solution, and rationale for section 95489(c)(5))*

## **Section 95489(f). Renewable Hydrogen Refinery Credit Program**

### Description of the Problem

Under the Renewal Hydrogen Refinery Credit Pilot Program provisions of the current regulation, credits are awarded based on GHG reductions achieved by substituting renewable hydrogen for fossil hydrogen in refineries. The current program is designated as a “pilot” program. This creates policy uncertainty around the long-term continuity of the program and may discourage refiners from making necessary investments.

### Proposed Solution

Staff is proposing to remove the “pilot” designation.

### Rationale Supporting the Proposed Solution

The removal of the “pilot designation” will create policy certainty for the program and encourage refiners to utilize renewable hydrogen thereby reducing the carbon intensity of CARBOB and diesel.

In addition, staff is proposing several changes to the program to simplify the credit calculation method and to improve the clarity and overall structure of the program. The changes related to the Renewable Hydrogen Refinery Credit Program are described in the problem, proposed solution and rationale for section 95485(d) above and 95489(f)(1), (2), and (5), below.

### **Section 95489(f)(1). General requirements**

#### Description of the Problem

The current regulation requires replacement of at least 1 percent of all fossil hydrogen by renewable hydrogen. This, and other restrictions discussed in the problem, solution and rationale for section 95485(d), above, could undermine incentives for the use of renewable hydrogen in refineries and thereby fail to provide significant potential GHG reductions.

#### Proposed Solution

Staff is proposing to delete the minimum 1 percent fossil hydrogen replacement requirement. See also the problem, solution and rationale for section 95485(d) for discussion of other restrictions staff is proposing to remove.

#### Rationale Supporting the Proposed Solution

Renewable hydrogen supply is expected to be limited in the near future. Hence, it may be difficult for refiners to secure enough renewable hydrogen supply to meet the minimum 1 percent fossil hydrogen replacement requirement and may discourage refiners from investing in renewable hydrogen production capacity and gaining experience or efficiency improvements. Removing this barrier will enable refineries to claim credits irrespective of the magnitude of renewable hydrogen use, and may encourage refiners to gradually scale-up renewable hydrogen use as the supply of renewable hydrogen increases.

### **Section 95489(f)(2). Calculation of Credits**

#### Description of the Problem

Currently credits under this program are calculated by comparing the CI of renewable hydrogen with the CI of natural gas-derived hydrogen produced via SMR at the refinery. The current method calls for calculating credits based on the Lookup Table pathway CI for fossil hydrogen, which includes life cycle emissions resulting from use in a vehicle. This can be problematic because hydrogen produced at refineries is used as a process input not as a transportation fuel. Additionally, estimating GHG emissions from SMR units is complicated due to integration of natural gas with refinery fuel gas, which act as feedstock and process fuel. Moreover, the current approach limits credit generation to



projects where renewable hydrogen replaces fossil hydrogen derived from SMR, whereas in reality renewable hydrogen can potentially replace the purchased hydrogen derived from other industrial processes such as fuel gas.

#### Proposed Solution

For SMR hydrogen involving a simple substitution of fossil natural gas with renewable natural gas, staff is proposing to estimate credits based on the amount and CI of fossil versus renewable natural gas used in SMR rather than requiring a calculation of the amount and CI of fossil vs renewable hydrogen produced by SMR.

For other hydrogen production pathways in refineries, including renewable energy electrolysis, staff is proposing to estimate carbon intensities of fossil and renewable hydrogen at the refinery by requiring applicants to submit applications for both fossil and renewable hydrogen to estimate well-to-refinery gate carbon intensities. The application process is similar to a Tier 2 fuel pathway application as described in section 95488.7.

Staff is proposing to clarify that this program applies to renewable hydrogen both produced on-site at a refinery and hydrogen purchased and supplied to a refinery.

#### Rationale Supporting the Proposed Solution

Staff expects the proposed change will not significantly impact the amount of credits generated but will make credit calculation, reporting, and enforcement under this program easier.

The GHG emissions associated with hydrogen production by methane reformation can vary widely depending on the source of biomethane. For example, refer to the CI values for hydrogen produced from a central reforming of natural gas compared to the CI of renewable hydrogen derived from landfill biomethane (see Table 7-1 in the Proposed Regulation Order). Based on this range and the quantity of natural gas used at California refineries for hydrogen production, substituting renewable hydrogen for hydrogen derived from fossil natural gas can potentially deliver GHG reductions of approximately 1 to 10 MMT CO<sub>2e</sub> per year. Given the potential for GHG reductions at the refineries through fossil hydrogen replacement, simplifying the credit calculation method and expanding the scope of the program can encourage investments in renewable hydrogen refinery projects.

#### **Section 95489(f)(5). Credit Issuance**

*(see the problem, solution, and rationale for section 95489(c)(5))*

## **SECTION 95490. PROVISIONS FOR FUELS PRODUCED USING CARBON CAPTURE AND SEQUESTRATION.**

### **Section 95490. Adoption of a CCS Protocol**

#### Description of the Problem

CCS is an important technology for reducing CO<sub>2</sub> emissions from large stationary sources.<sup>59,60</sup> In light of California's mid- to long-term climate goals,<sup>61,62</sup> CCS may grow in importance for California as a climate change mitigation measure. As such, the current LCFS regulation includes provisions for CCS projects to receive credit once CARB adopts a quantification methodology (QM). The LCFS requires that the QM include monitoring, reporting, verification, and permanence requirements. Additionally, all GHG emissions reductions credited under LCFS from CCS projects must be real, permanent, quantifiable, verifiable, and enforceable.

#### Proposed Solution

Staff has developed the "Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard," hereafter referred to as the "CCS Protocol." Staff proposes to adopt and incorporate the CCS Protocol into the LCFS regulation by reference. The CCS Protocol includes both "Accounting Requirements" and "Permanence Requirements" and, if adopted, would satisfy the need for a CCS QM in the LCFS. The Accounting Requirements specify how to calculate net GHG emissions reductions associated with CCS projects. The Accounting Requirements cover emissions from: CCS operations, CO<sub>2</sub> atmospheric leakage, above ground fugitive emissions, and post closure emissions. The Permanence Requirements include provisions to ensure that GHG emissions reductions from CCS are permanent by remaining sequestered for at least 100 years. CCS projects must comply with the totality of the CCS Protocol criteria in order to obtain permanence certification.

The current LCFS regulation includes provisions for fuels to generate credits using CCS, including refinery investment credits, innovative crude production credits, and provisions for fuel pathways. Potential CCS projects that would qualify under the above provisions include CO<sub>2</sub> capture at ethanol production facilities, on-site capture at oil and gas extraction facilities, and CO<sub>2</sub> capture from steam methane reforming at refineries. In addition, staff is proposing provisions for crediting direct air capture projects.

---

<sup>59</sup> IPCC, 2014, Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

<sup>60</sup> California Council on Science and Technology (CCST), 2011, California's Energy Future: The View to 2050.

<sup>61</sup> California Senate Bill 32, Pavley, 2016.

<sup>62</sup> California Governor Brown Executive Order No. B-30-15 (2015), and California Governor Schwarzenegger Executive Order S-03-05 (2005)

### Rationale Supporting the Proposed Solution

The purpose of the CCS Protocol is to establish eligibility requirements for CCS projects to qualify for credits under the LCFS. The Accounting Requirements provide a quantification methodology for calculating CI values and credits for eligible CCS projects. The Permanence Requirements specify requirements for site selection, well construction, monitoring, and verification, to ensure that all GHG emissions reductions achieved are real, permanent, quantifiable, verifiable, and enforceable.

### **Section 95490(a). Eligibility**

#### Description of the Problem

It is necessary for regulations to clearly define the entities that are covered by them.

#### Proposed Solution

The proposed eligibility requirements describe which entities are eligible to submit project applications and, if approved, receive CCS credits.

#### Rationale Supporting the Proposed Solution

Eligibility requirements that clearly define the entities that are covered by a regulation is a necessary element of the regulation.

### **Section 95490(a)(2). Direct Air Capture and Sequestration Provision**

#### Description of the Problem

Direct air capture and sequestration is a method that removes CO<sub>2</sub> from the atmosphere directly and geologically sequesters the resultant CO<sub>2</sub>. If CO<sub>2</sub> derived from direct air capture is converted to fuels, applicants may apply for fuel pathway certification using the Tier 2 pathway application as described in section 95488. However, under the current LCFS, direct air capture and sequestration is not eligible for project-based CCS credits.

#### Proposed Solution

Staff proposes to make direct air capture and sequestration projects eligible for project-based CCS credits. Under this proposal, direct air capture projects would be subject to the same accounting and permanence requirements as any other CCS project types.

#### Rationale Supporting the Proposed Solution

Direct air capture and sequestration is an emerging technology that has the potential to reduce large amounts of CO<sub>2</sub> in the atmosphere. Direct air capture and sequestration could aide in achieving California's long-term climate goals.

### **Section 95490(b). General Requirements**

#### Description of the Problem

Although the current LCFS regulation has provisions that include CCS as an eligible method to generate credits, it does not include a Board Approved QM with Accounting

and Permanence Requirements necessary to ensure proper crediting and permanent sequestration.

#### Proposed Solution

Staff proposes to adopt section 95490(b), which specifies general requirements for CCS projects under the LCFS. This section requires compliance with the CCS Protocol, which consists of Accounting Requirements and Permanence Requirements. The Accounting Requirements ensure clarity and detail on the methodology for determining emissions reductions and corresponding credit generation. The Permanence Requirements provide criteria to ensure the CCS project achieves permanent sequestration of CO<sub>2</sub> for at least 100 years.

#### Rationale Supporting the Proposed Solution

The Accounting Requirements provide the quantification methodology for determining emission reductions and credits generated. The purpose of the Permanence Requirements is to establish requirements for permanent geologic carbon sequestration that CCS projects can follow in order to qualify for credits under the LCFS. The prerequisite requirements for permanence set forth criteria and standards that CCS projects must implement in order to acquire certification for any sequestration sites and wells used to inject CO<sub>2</sub> for the purpose of geologic sequestration. The purpose of these criteria and standards are to ensure that any credited GHG emissions reductions under the LCFS are real, permanent, quantifiable, verifiable, and enforceable.

### **Section 95490(b)(3). Proration Requirements**

#### Description of the Problem

The intent of the LCFS is to reduce the carbon intensity of transportation fuel used in California. Therefore, fuels not consumed in California are not eligible for credit generation under LCFS.

#### Proposed Solution

Staff proposes to prorate credits based on the quantity of fuels produced using CCS and how much of that fuel is sold in California. Staff proposes to exempt direct air capture and sequestration from this provision.

#### Rationale Supporting the Proposed Solution

Prorating credits based on the quantity of fuels produced and sold in California ensures that the intent of LCFS to reduce the carbon intensity for California fuels is met. The exemption for direct air capture and sequestration would allow LCFS to spur innovation in technologies that have the potential to reduce large amounts of CO<sub>2</sub> in the atmosphere. Staff believes it is important to encourage the development of direct air capture and sequestration. In the near future, staff anticipates direct air capture and sequestration projects will be limited and will not significantly impact the LCFS market.

## **Section 95490(c). Application Contents and Submittal**

### Description of the Problem

CCS project applicants need clarity on application submittal including submission contents, applicant status, and the steps of the process.

### Proposed Solution

Staff proposes that the application must be filed jointly by the entity that captures CO<sub>2</sub> and the entity that sequesters the resultant CO<sub>2</sub>, unless the same entity is responsible for both CO<sub>2</sub> capture and sequestration. Section 95490(c) also specifies the materials that must be contained in an application and how to submit an application.

### Rationale Supporting the Proposed Solution

A clear application process with detailed requirements is necessary to ensure that applicants have certainty in how to apply and what to include in the application.

## **Section 95490(d). Application Approval Process**

### Description of the Problem

CCS project applicants need clarity on the application approval process.

### Proposed Solution

Section 95490(d) describes the procedures that staff proposes for the application approval process including actions taken after receipt of the application, applicant notification of further required actions, and application approval or disapproval.

### Rationale Supporting the Proposed Solution

Section 95490(d) provides public access to information about CARB's decision-making process, which is consistent with CARB's commitment to a transparent public process.

## **Section 95490(e). Reporting**

### Description of the Problem

CCS projects can generate credits or deficits under the LCFS program. It is necessary for the applicants to report sufficient data for determining and verifying the amount of credits or deficits.

### Proposed Solution

Staff proposes that each CCS project must adhere to the reporting requirements in the CCS Protocol in addition to the reporting requirements in the regulation.

### Rationale Supporting the Proposed Solution

CCS projects have unique requirements and features, such as subsurface monitoring, not present for other projects or fuel pathways. Additional data reporting requirements are necessary to determine the net amount of CO<sub>2</sub> sequestered and to demonstrate the permanence of the sequestered CO<sub>2</sub>.

## **Section 95490(f). Credit Review and Issuance**

### Description of the Problem

CCS projects must adhere to the third-party verification system being proposed for the LCFS.

### Proposed Solution

Staff is proposing that CCS projects will be subject to verification of reported data from the applicable Project Reports prior to the issuance of credits. Verification (and thus credit issuance) can be scheduled quarterly or annually, at the option of the CCS Project Operator.

### Rationale Supporting the Proposed Solution

Verification of project data for CCS projects prior to the issuance of credits will help ensure that the credits are accurate and valid. Staff proposes flexibility in the frequency of verification so that operators can weigh the benefits of more frequent credit generation against the cost of verification. Small credit generators may elect to undergo less frequent verification and credit generation to minimize the overall cost of verification. Conversely, large credit generators may elect to monetize the credits more frequently.

## **Section 95490(g). Recordkeeping**

### Description of the Problem

CARB or a third-party verifier may need to view records in order to verify relevant CCS project data prior to crediting. It is also necessary to maintain records for verifying permanent sequestration of CO<sub>2</sub>.

### Proposed Solution

Staff proposes to require each approved CCS credit generator to maintain records for the CCS project, including records necessary to verify the project's claims of net sequestered CO<sub>2</sub>.

### Rationale Supporting the Proposed Solution

The requirements in Section 95490(f) are necessary to ensure that sufficient data and documentation are maintained to demonstrate compliance with the regulation and the CCS Protocol.

## **Section 95490(h). CO<sub>2</sub> Leakage and Credit Invalidation**

### Description of the Problem

The LCFS needs to properly account for carbon intensity for the entire market. In the unlikely case sequestered CO<sub>2</sub> is leaked into the atmosphere, the associated credits would need to be invalidated.

### Proposed Solution

Section 95490(g) specifies the methods to determine the amount of CO<sub>2</sub> leakage and associated credits to be invalidated in accordance with the CCS Protocol.

### Rationale Supporting the Proposed Solution

In the unlikely event sequestered CO<sub>2</sub> leaks to the atmosphere from a credited CCS project, there is a need to quantify the CO<sub>2</sub> leakage and invalidate the credits in order to properly account for carbon intensity in the LCFS market.

## **SECTION 95491. FUEL TRANSACTIONS AND COMPLIANCE REPORTING.**

### **Section 95491. Fuel Transactions and Compliance Reporting**

#### Description of Problem

The purpose of this section is to provide requirements for quarterly fuel reporting and annual compliance reporting in the LRT-CBTS. Staff seeks to clarify the reporting requirements in this section.

#### Proposed Solution

Staff is proposing to re-organize the existing and proposed reporting requirements in separate sections for better readability.

#### Rationale Supporting Proposed Solution

The proposed changes make it easier to find and refer to the relevant reporting requirements for all fuel types. Most of the deletions and additions in this section are a result of this restructuring or new provisions added in prior sections. Other changes not related to this restructuring are explained below.

### **Section 95491(c) and (d). General and Specific Reporting Requirements for Quarterly Fuel Transactions Reports**

#### Description of Problem

This section in the current regulation provides general and specific requirements for quarterly fuel transactions reporting. Providing general and specific reporting requirements for each fuel under same subsection may result in confusion.

#### Proposed Solution

Staff is proposing to split the existing subsection in two subsections, subsection 95491(c) focused on general reporting requirements and subsection 95491(d) on specific reporting requirements for Quarterly Fuel Transactions Reports for each fuel type.

Staff is providing, in subsection 95491(b), a comprehensive list of the general reporting parameters applicable for Quarterly Fuel Transactions Reports for all fuel types.

### Rationale Supporting Proposed Solution

The proposed change will make it easier for reporting entities to find and follow the general and specific reporting requirements for each fuel type.

#### **Section 95491(d)(1). Specific Quarterly Reporting Parameters for Alternative Jet Fuel**

### Description of Problem

The proposed amendments allow alternative jet fuel to generate credits under the LCFS; staff needs to provide specific requirements for reporting alternative jet fuels in the LRT-CBTS.

### Proposed Solution

Staff is proposing to provide specific parameters to be included in the quarterly reporting requirements for alternative jet fuels in the LRT-CBTS.

### Rationale Supporting Proposed Solution

As staff is proposing to include alternative jet fuels in the program, there need to be corresponding reporting requirements.

#### **Section 95491(d)(1)(B). Temperature Correction**

### Description of Problem

As the volume of liquid fuels is dependent on the temperature at which it is measured, it is important that all the fuel volumes reported in the LRT-CBTS be adjusted to standard temperature conditions. The current regulation does not expressly provide any methodology or guidance for using standard temperature conditions for reporting fuel quantities.

### Proposed Solution

Staff is proposing all liquid fuel volumes must be adjusted to standard temperature conditions of 60 degree Fahrenheit for reporting in the LCFS. Staff is proposing the methodologies used for adjusting ethanol and biodiesel volumes to the standard temperature conditions as provided in the U.S. EPA RFS and for other liquid fuels the methodology provided in California's Mandatory Greenhouse Gas Reporting Regulation (MRR).

### Rationale Supporting Proposed Solution

This change will allow reporting entities to use standard methods for adjusting fuel quantities for reporting in LCFS ensuring consistent fuel reporting among all the entities. Further, proposing temperature corrections as provided in the RFS and MRR would help harmonize LCFS requirements with other programs without creating any disruption in industry practices.



## **Section 95491(d)(1)(C). Fuel Pathway Allocation for Produced Fuel**

### Description of Problem

In some circumstances, multiple feedstock-specific CIs may be generated by the same facility. The facility's operational yield may vary from the average yield determined at pathway certification, depending on the shares of feedstocks consumed. A clear methodology is necessary for allocating fuel quantities by feedstock.

### Proposed Solution

Staff proposes that the facility-wide average yield across all feedstocks determined at pathway certification will be used for subsequent reporting periods to determine the quantity of fuel allocated to each fuel pathway code. If the actual yield at the facility exceeds the yield at certification, staff proposes that the marginal increase in fuel quantity will be allocated to the pathway with the highest CI from that facility. Staff proposes that a different methodology may be used with Executive Officer approval. This methodology must be included in the monitoring plan.

### Rationale Supporting Proposed Solution

This proposed allocation methodology provides a clear and sufficiently conservative method of assigning fuel quantities to multiple pathways produced at a single facility.

## **Section 95491(d)(1)(D). Exports**

### Description of Problem

The LCFS regulation requires that if fuel reported in the LRT-CBTS is subsequently exported out of California then it must be reported in the LRT-CBTS as export by the entity exporting the fuel pursuant to section 95483(e). However, in some cases sufficient information may not be available for reporting exports. For example, the actual blend percentage in the fuel or the fuel pathway code under which the exported fuel was originally reported might not be available to the person exporting.

### Proposed Solution

Staff is proposing to provide default blend percentages and Substitute pathways when that information is not available for reporting fuel exports. Staff is proposing the default blend percentage values and CI values for Substitute pathways be based on prior year average values. Staff's proposal is to post these values on the LCFS website and update as necessary.

### Rationale Supporting Proposed Solution

The proposed change will provide clear guidance and assist entities in reporting fuel exports when actual blend percentages or pathway of the fuel are not available for reporting in LRT-CBTS.

## **Section 95491(d)(2) to (5). Reporting by FSE of CNG, LNG, L-CNG, Electricity, Hydrogen and Propane**

### Description of Problem

In the first quarter of 2017, the LRT-CBTS was updated with a new module to support Fueling Supply Equipment (FSE) registration for non-liquid fuels including Electricity, CNG, LNG, L-CNG, and Hydrogen. Reporting entities have to register the FSE through which the fuel is dispensed before they can start reporting for generating credits. This ensures only one entity is reporting and claiming credits for a fuel type dispensed at a registered fueling supply equipment. FSE reporting is intended to improve the data quality for these fuels and help prevent potential double counting of fuel quantities dispensed in California. Entities are already reporting these fuels per FSE in the LRT-CBTS but the current regulation does not provide specific reporting requirements.

### Proposed Solution

Staff is proposing to require reporting of CNG, LNG, L-CNG, electricity, hydrogen and propane per FSE.

### Rationale Supporting Proposed Solution

This change will avoid duplicate reporting of fuel quantities in LRT-CBTS as each unit of fuel reported will be identified with a unique FSE. This will streamline reporting and verification and ensure that the fuel for which credits are claimed is used for transportation in California.

## **Section 95491(d)(2)(A). Reporting Units for CNG and L-CNG**

### Description of Problem

In the current regulation, the quantity of CNG and L-CNG dispensed is required to be reported in standard cubic feet (scf), but these fuels are typically supplied in energy units.

### Proposed Solution

Staff is proposing to change the reporting units for CNG and L-CNG from scf to Therms. Specifically, the quantity of CNG and L-CNG dispensed must be reported in Therms at Higher Heating Value (HHV) as shown on utility bills.

### Rationale Supporting Proposed Solution

The proposed change is consistent with the industry practices and will standardize reporting of CNG and L-CNG fuel quantities. The current regulation prescribes a formula for converting fuel quantity from pounds to scf. However, as the industry quantifies CNG and L-CNG in Therms, the reporting entities first have to convert fuel quantity from Therms to pounds before it can be converted to scf. These conversions may result in errors or inconsistencies while reporting CNG and L-CNG fuel in the LRT-CBTS.

### **Section 95491(d)(2)(C). Total Fuel Quantity for Natural Gas**

#### Description of Problem

In the current regulation, the total quantity of natural gas dispensed is not required, therefore the amounts reported per FPC cannot be reconciled.

#### Proposed Solution

Staff is proposing to add a new requirement asking for total throughput during a period for reconciliation purposes.

#### Rationale Supporting Proposed Solution

The proposed change will improve the data accuracy in LRT-CBTS.

### **Section 95491(d)(3). Specific Quarterly Reporting Parameters for Electricity used as a Transportation Fuel**

#### Description of Problem

Because staff proposes to combine the Private Access and EV Fleet Charging categories in section 95483, and to add new mechanisms to recognize reduction in carbon intensity of electricity, quarterly reporting requirements for these categories need to be updated correspondingly in section 95491.

Staff has observed that transaction types are inconsistently used among electricity reporting entities in their quarterly reporting. The transaction types are specified to assist compliance and ensure consistent reporting.

#### Proposed Solution

Staff is proposing to combine the reporting requirements for Private Access and EV Fleet Charging.

Staff proposes that transaction type “EV Charging” be used for all types of on-road applications. That category will be subdivided to recognize charging transactions using grid electricity (EV Charging – Grid), Tier 2 and lookup table pathways based on lower carbon electricity supply (EV Charging – Non-grid), and Lookup Table pathways based on smart charging shifting the time of charging to when low-CI electricity is available (EV Charging – TOU).

The categories of “Fixed Guideway Fueling”, “Forklift Electricity Fueling”, and “e-TRU Fueling” are proposed to be used as transaction types for these off-road applications, respectively.

Staff is also providing clear reporting requirements for electric forklifts and establishing a hierarchy for claiming credits by EDU and fleet operators. In the case when EDU is claiming credits, the credits will be calculated annually by staff, and will be exempted from the quarterly reporting deadlines.

#### Rationale Supporting Proposed Solution

The proposed standardized electricity transaction types will ensure consistent reporting, and the proposed amendment to electric forklift reporting requirements clarifies the reporting requirements for different entities claiming credits.

#### **Section 95491(d)(4). Specific Quarterly Reporting Parameters for Hydrogen Used as a Transportation Fuel**

##### Description of Problem

The specific reporting requirements for hydrogen needs to be updated to streamline with the other proposed changes to hydrogen provisions including fuel reporting entity designation and credit generation using fuel pathways.

##### Proposed Solution

Staff proposes that transaction type “FCEV Fueling” be used for reporting hydrogen used in all types of on-road applications including LDV, MDV and HDV applications. For reporting hydrogen that claims carbon intensity reductions for shifts in time of electricity use for electrolytic hydrogen production, transaction type “FCEV Fueling – TOU” should be used. Staff is proposing transaction type “Forklift Hydrogen Fueling” be used for reporting hydrogen used in forklifts.

#### Rationale Supporting Proposed Solution

The proposed changes standardize transaction types for hydrogen reporting, ensuring consistent reporting.

#### **Section 95491(d)(5). Specific Quarterly Reporting Parameters for Propane**

##### Description of Problem

Since staff is proposing to include propane in the LCFS, staff needs to provide specific requirements for reporting propane in the LRT-CBTS.

##### Proposed Solution

Staff is proposing to provide specific parameters to be included in the quarterly reporting of propane in the LRT-CBTS that are based on existing reporting requirements for other gaseous fuels.

#### Rationale Supporting Proposed Solution

This change will establish clear reporting requirements for propane, which are similar to requirements for natural gas.

#### **Section 95491(e)(1)(G). Credit Pledged for Sale in CCM in Annual Summary**

##### Description of Problem

The current language includes credits exported out of the LCFS program. That language is unnecessary because staff is proposing to remove the credit exporting

provision. The current language does not include credits pledged for sale in CCM in the annual summary.

#### Proposed Solution

Staff is proposing to add a requirement to report credits pledged to the CCM, and remove the requirement to include credits exported out of the LCFS program because staff is also proposing to remove the provision for exporting LCFS credits to other programs (see the problem, solution, and rationale for section 95487(a)(1)(C)).

#### Rationale Supporting Proposed Solution

Reporting pledged credits will allow for complete accounting. The credit export reporting requirement will no longer be needed given changes proposed in section 95487(a)(1)(C)).

### **Section 95491(e)(3). Pending Credit Transfers at the Time of Annual Compliance Report Submission**

#### Description of Problem

The current language does not provide clarity on how pending credit transfers will be taken into account at the time of annual compliance report submission.

#### Proposed Solution

Staff is providing clarification about how pending credit transfers will be taken into account at the time of annual compliance report submission. Staff is also proposing a process in case these pending credits transfers are completed after the submission of the annual compliance report.

#### Rationale Supporting Proposed Solution

This will establish a clear process for processing pending credit transfers at the time of annual report submission and will allow for accurate accounting of credits involved in these pending credit transfers.

### **Section 95491(g). Total Obligated Amount and Total Amount**

#### Description of Problem

The current regulation requires an entity reporting fuel to maintain a non-negative value for Total Obligated Amount for each FPC as summed across all quarterly data in the LRT-CBTS. However, it does not provide clarification on maintaining non-negative balance of Total Fuel Amounts.

#### Proposed Solution

Staff is proposing an entity reporting fuel must also maintain a non-negative value for Total Amount for each fuel pathway as summed across all quarterly data in the LRT-CBTS.

#### Rationale Supporting Proposed Solution

This change will streamline the regulatory requirements with existing accounting practices implemented in LRT-CBTS. Moreover, maintaining a non-negative value for Total Amount will prevent over drafting of fuel quantities ensuring accurate accounting of fuels inventory in LRT-CBTS accounts.

### **Section 95491. Table 11: Summary Checklist of Quarterly and Annual Reporting Requirements**

#### Description of Problem

The purpose of the table is to summarize the quarterly and annual reporting parameters for different types of fuels. With changes being proposed, the table needs to be updated.

#### Proposed Solution

Staff is proposing to update the table to reflect the proposed changes in the quarterly and annual reporting requirements.

#### Rationale Supporting Proposed Solution

The update helps reporting entities identify important parameters for reporting.

### **Section 95491. Table 12: Annual Compliance Calendar**

#### Description of Problem

The purpose of the “Annual Compliance Calendar” is to provide all the deadlines and milestones for a compliance year. With changes being proposed, some of the existing deadlines need to be updated and new deadlines related to verification need to be added in the calendar.

#### Proposed Solution

Staff is proposing to update existing deadlines and add new deadlines to reflect the proposed changes in the regulation.

#### Rationale Supporting Proposed Solution

The change will ensure the “Annual Compliance Calendar” is updated and can help regulated entities identify important deadlines and milestones for a compliance year.

### **SECTION 95491.1. RECORDKEEPING AND AUDITING.**

#### Description of Problem

In the current regulation, the recordkeeping requirements pertaining to different sections are provided in respective sections. There is no single location that provides all the all recordkeeping requirements for ease of reference.

### Proposed Solution

Staff proposes to create a new section 95491.1 for all the recordkeeping and auditing requirements under LCFS. This includes recordkeeping requirements specific to fuel reporting entities, fuel pathway holders and applicants, and verification bodies.

### Rationale Supporting Proposed Solution

The change will improve readability by consolidating all recordkeeping requirements in a single location.

## **Section 95491.1(a)(1)(A). Record Retention for Fuel Reporting Entities**

### Description of Problem

The recordkeeping requirements in the current regulation need to be updated to reflect the other changes proposed by the staff related to fuels reporting.

### Proposed Solution

Staff is proposing to update the recordkeeping requirements for fuel reporting entities to include information related to credit transactions, FSE registration related and chain of custody evidence for fuel that is imported into California.

### Rationale Supporting Proposed Solution

This change will help fuel reporting entities comply with recordkeeping requirements.

## **Section 95491.1(a)(2). Record Retention for Fuel Pathway Holders and Applicants**

### Description of Problem

During the review of the pathway, the Executive Officer or third-party verifier may need to verify a relevant input to the pathway that is not covered in the recordkeeping requirements listed in 95488(d)(7). Recordkeeping requirements currently require fuel pathway holders to maintain records for all of the parameters related to certification of a fuel pathway application. This requirement may not include all of the site-specific inputs in the certified pathway. In order to ensure third-party verifiers have the evidence necessary to check inputs for ongoing verification, the recordkeeping requirements need to be updated to account for all data subject to verification.

### Proposed Solution

Staff proposes fuel pathway holders be required to retain all records relevant to the calculation of the pathway's CI. This proposal includes records demonstrating compliance with operating conditions and any special conditions applicable to the certified fuel pathway application.

### Rationale Supporting Proposed Solution

Staff proposes that the Executive Officer be granted the authority to request any additional records. This would ensure that sufficient documentation is maintained to demonstrate compliance with the regulation and facilitate verification.

## **Section 95491.1(a)(2)(F). Chain of Custody Evidence for Specified Source Feedstock**

### Description of Problem

See description of problem for 95488.8(g)(1)(B).

### Proposed Solution

See proposed solution for 95488.8(g)(1)(B). In addition, staff proposes that applicants maintain a copy of the U.S. EPA RFS Program Separated Food Waste Plan, where applicable, to be provided to verifiers or to the Executive Officer upon request.

### Rationale Supporting Proposed Solution

Please see the rationale for 95488.8(g)(1)(B). In addition, the Separated Food Waste Plan may encompass entities in the supply chain that are left out of the chain of custody documentation that is maintained. Providing the Separated Food Waste Plan when requested may provide a comprehensive picture of the feedstock supply chain for fuel pathways involving specified source feedstocks.

## **Section 95491.1(b). Documenting Fuel Transfers for LRT-CBTS Transactions**

### Description of Problem

In the current regulation the entity receiving the ownership of fuel is referred to as “transferee” in this section. However, it is referred to as “recipient” in section 95483.

### Proposed Solution

Staff is proposing to replace “transferee” with “recipient”.

### Rationale Supporting Proposed Solution

The change will ensure the language used is consistent throughout the regulation.

## **Section 95491.1(b)(1). Date of Transactions**

### Description of Problem

In the current regulation, the transaction date to be reported on Product Transfer Documents (PTD) for non-aggregated transactions is the date of title transfer and for aggregated transactions it the quarter end date. However, as staff is proposing requiring the transferor to provide a PTD to the recipient by the time of transfer, it would not be relevant to put the quarter end date as the transaction date.

### Proposed Solution

Staff is proposing to require the the transaction date to be reported as the date of title transfer, and to remove the option for aggregated transaction types.



### Rationale Supporting Proposed Solution

As staff is proposing requiring the transferor to provide a PTD to the recipient by the time of transfer, each transfer will generate a PTD. Thus, each PTD should record the actual date title transfer. This granularity of information will also help verifiers to ensure the accuracy of fuel transactions reported in the LRT-CBTS.

### **Section 95491.1(c). Monitoring Plan for Entities Required to Validate or Verify under the LCFS**

#### Description of Problem

Staff is proposing a comprehensive verification system to audit all fuel pathway applications and to check for ongoing compliance after certification, as well as verification of reported fuel quantities and project reports. In order to check the validity of all parameters and ensure measurement accuracy provisions are upheld within the constraints of the verification schedule outlined in 95500, staff is proposing a risk-based audit approach for certain parameters. Detailed documentation of the facility and management practices is needed in order to determine the level of intensity with which certain parameters need to be checked during validation and verification.

#### Proposed Solution

Staff is proposing to require that entities responsible for validation or verification complete and retain a monitoring plan for review by a verifier or the Executive Officer. Entities reporting pursuant to the MRR program may use a single monitoring plan for the MRR and LCFS, as long as all the elements described in 95491.1(c) are included. The monitoring plan is made available to the verifier and Executive Officer upon request and must be generated before third-party review of data and updated on a regular basis to accurately capture current facility operations. Facilities regulated under MRR may use their existing monitoring plans, but must ensure that all elements listed in the 95491.1(c) are included in the monitoring plan submitted to the LCFS. The detailed list in 95491.1(c) includes documentation of several general elements, summarized here: general description of the facility and existing audit programs; description of existing recordkeeping plans and management policies; explanation of processes in place to report fuel quantities required under this subarticle; location and identification of measurement devices and how these devices are maintained and calibrated pursuant to the measurement accuracy requirements in 95488.8(j), including OEM recommended intervals; a historical log of calibration actions taken for measurement devices; documentation of equations used to calculate mass, volume or energy flows; identification of job titles and training practices pursuant to compliance with this subarticle; records of corrective/preventative actions taken to address past nonconformance issues; and a log of modifications to Fuel Pathway Reports in response to third-party verifier review.

Staff also proposes to require documentation of a number of elements specific to fuel pathway CI calculations and fuel quantity reporting. This documentation covers all site-specific data submitted in fuel pathway applications and the methodologies for generating/calculating this data. This includes a detailed description of the calculation

methodology used to generate weighted average transport/transmission distances. These requirements also cover methodologies for aggregating fuel volumes to particular FPCs and all chain-of-custody documentation for specified source feedstocks, in addition to chain-of-custody documentation proving that fuel quantities were delivered to California for transportation use. The monitoring plan must reference documentation that can be used to justify transaction types reported for fuel in the LRT-CBTS.

#### Rationale Supporting Proposed Solution

The monitoring plan is intended to serve as a roadmap to demonstrate how the entity responsible for validation or verification plans to maintain compliance with the requirements of the LCFS. A detailed monitoring plan reduces onboarding time for new verifiers as the plan is used to inform the verifier's basic understanding of the facility and operations, who to talk to during the site visit, initial risk assessment, and decisions for upstream specified source data checks and site visits.

### **Section 95491.1(d). Verification Outcomes**

#### Description of Problem

In the current regulation, any data and calculations submitted by a regulated party for demonstrating compliance or claiming credit are subject to verification by the Executive Officer or a third-party approved by the Executive Officer. As staff is proposing to require third-party verification in the LCFS program, this section needs an update.

#### Proposed Solution

Staff is proposing to update the section to provide reference to the detailed requirements for third party verification proposed in section 95500 to 95503. Staff is also clarifying that an adverse verification statement would result in Executive Officer investigation.

#### Rationale Supporting Proposed Solution

This change will help provide clear direction to verification requirements in the regulation and the outcomes in case of an adverse verification statement.

### **SECTION 95492. ENFORCEMENT PROTOCOLS.**

#### Description of Problem

Because staff is proposing to add new requirements for recordkeeping and reporting in various sections of the regulation, and to eliminate the fuel transport mode demonstration, the section governing enforcement protocols contains inaccurate references.

#### Proposed Solution

Staff is proposing to remove the specific reference to the demonstration of fuel transport mode and subsections that contain recordkeeping and reporting requirements, and instead refer to such requirements throughout the subarticle.

#### Rationale Supporting Proposed Solution

The proposed change will avoid confusion and clarify that the enforcement protocol may be entered into for any requirement, demonstration, or recordkeeping provision in the regulation.

### **SECTION 95493. JURISDICTION.**

#### Description of Problem

Since staff is proposing to update the terminology used to define participants to clarify their roles and responsibilities, updates to the jurisdiction section are needed to maintain consistency with these proposed changes.

#### Proposed Solution

Staff proposes to modify the references and to list specifically each of the entities who, by participating in the LCFS program, would be subject to the jurisdiction of the State of California, and specifically which actions constitute participation.

#### Rationale Supporting Proposed Solution

These changes maintain consistency with other proposed regulation changes and clarify the persons subject to the jurisdiction of the State of California courts for enforcement purposes.

### **SECTION 95494. VIOLATIONS.**

#### **Section 95494(b). Verification Outcomes**

#### Description of Problem

The current regulation defines “report” to mean any submittal to the Executive Officer or made in the LRT-CBTS, but is not specific.

#### Proposed Solution

Staff proposes to modify the definition of “report”.

#### Rationale Supporting Proposed Solution

This change clarifies what is considered a “report” in the LCFS.

### **SECTION 95495. AUTHORITY TO SUSPEND, REVOKE, MODIFY OR INVALIDATE.**

#### Description of Problem

Currently, in case of invalidation, any entity that generated, previously held, or holds invalidated credits is responsible for returning its account to compliance without regard to fault. As staff is proposing the Executive Officer may retire credits from the buffer account to ensure program’s environmental integrity if the person responsible for the credits’ invalidity no longer exists, or is otherwise unavailable to reimburse the program, it need to be reflected in the provisions governing invalidation of credits.

#### Proposed Solution

Staff proposes to specify that credits placed in the buffer account can be retired in the situation where invalid credits or uncovered deficits cannot be addressed by the entity that is deemed responsible for the deficits or invalidation.

#### Rationale Supporting Proposed Solution

This change supports other efforts to ensure environmental integrity of the program.

### **SECTION 95496. REGULATION REVIEW (DELETED).**

#### Description of Problem

This section provides requirements for a progress report and a program review that must be fulfilled by January 2019, which will be expired and no longer relevant by the time the proposed regulation is expected to be effective.

#### Proposed Solution

Staff proposes to strike the text and reserve the section for future amendments.

#### Rationale Supporting Proposed Solution

Staff is seeking to reduce the length of the regulation to improve clarity and readability by removing provisions that are unused, expired, or no longer relevant.

### **SECTION 95497. SEVERABILITY.**

*(No proposed changes.)*

### **SECTION 95498. [RESERVED].**

### **SECTION 95499. [RESERVED].**

### **SECTION 95500. REQUIREMENTS FOR VALIDATION OF FUEL PATHWAY APPLICATIONS, VERIFICATION OF ANNUAL FUEL PATHWAY REPORTS, QUARTERLY FUEL TRANSACTIONS REPORTS, CRUDE OIL QUARTERLY AND ANNUAL VOLUMES REPORTS, AND PROJECT REPORTS.**

#### Description of Problem

Staff is proposing that data reported under LCFS be subject to third-party verification, to ensure that data reported and used to determine compliance is accurate and conforms to the requirements of the regulation. The regulation must specify which data are subject to third-party verification, the frequency at which verification is required, and the deadlines for completing verification. In addition, the regulation must specify which regulated entities are responsible for contracting verification services and which entities are subject to third-party verification.

#### Proposed Solution

Starting in 2020, the initial and ongoing review of submitted data and supporting documentation would no longer be conducted by CARB staff, except for targeted quality

assurance and control checks to ensure the validity and consistency of reported data, and to audit the quality of verification services provided by CARB-accredited verifiers. Fuel pathway applicants, fuel pathway holders, and other reporting entities would be required to undergo verification of their LCFS reports by a third-party verifier accredited by CARB.

#### Rationale Supporting Proposed Solution

The entities required to contract for verification services are either designated as regulated entities or elect to become regulated entities to participate in the LCFS. Additionally, the regulated entities either have the source data needed to support LCFS credits or deficits calculations, or would be responsible for providing access for CARB staff and verifiers through business relationships.

CARB must effectively implement and oversee a third-party verification and accreditation program for LCFS to ensure the accuracy and validity of data reported under the program. Therefore, it is necessary to ensure only qualified individuals are conducting verification services and reviewing the accuracy of reported data. For this reason, this section specifies that entities required to contract for verification services may only engage verifiers accredited by CARB to perform verification under LCFS.

The implementation timing provides entities required to contract for verification services a reasonable timeframe within which to comply with the amended regulation.

### **Section 95500(a). Validation of Fuel Pathway Applications (CIs)**

#### Description of Problem

The current application process for fuel pathways consists of application submittal, CARB review of supporting evidence for site-specific CI inputs provided by fuel pathway applicants, and CARB approval or rejection of requested fuel pathways and corresponding CI values. To ensure accurate and complete data are relied upon for the generation of LCFS credits after pathway certification, third-party verification is needed. CARB must identify which entities are required to contract for verification services to validate fuel pathway applications and which entities along the fuel supply chain require a site visit.

#### Proposed Solution

Staff proposes to require third-party review of substantiating documentation and calculations for fuel pathway applications, including provisional pathways, which will expedite the fuel pathway certification process. Fuel pathway applicants would be required to contract for verification services from a CARB-accredited verification body that would render a validation statement prior to CARB's certification of the fuel pathway. As part of verification services, fuel pathway applicants must meet requirements for site visits to ensure that reported information and supporting documentation is robust and traced back to its origin, using a risk based approach.

Other entities generating site-specific CI data and specified source feedstock suppliers may elect to become regulated entities and engage a verifier independent of the liquid fuel production facility or an entity required to contract for validation of natural gas or propane CIs.

#### Rationale Supporting Proposed Solution

Third-party validation of the submitted application is needed to ensure the validity of the assertions and accuracy of the data submitted to CARB, and to expedite fuel pathway approval, so credits can continue to be generated in a timely manner. Third-party validation will provide greater confidence in the credits based on the certified CI validated under this step.

Entities required to contract for verification services must ensure the site visits required in section 95501(b)(3) are conducted, because they are reasonably necessary for confirmation of facility operations, review of substantiating documents for site-specific CI inputs, and interviews with key personnel. The options provided to specified source feedstock suppliers are necessary for the following reasons:

- to allow confidentiality to be maintained for business relationships with suppliers further upstream to feedstock points of origin and
- to reduce the potential for duplicative validations and verifications given that feedstock suppliers may supply multiple pathway applicants.

#### **Section 95500(b). Verification of Annual Fuel Pathway Report (CIs)**

##### Description of Problem

Currently, CARB staff conducts compliance audits to ensure that feedstock supplies and fuel production processes are consistent with certified pathways and that accounting methods to assign FPCs to fuel transactions conform to the regulation. To ensure accurate data are relied upon for the generation of LCFS credits after pathway certification, a system to monitor, report, and verify operational CI on an ongoing basis is needed. CARB must identify which entities are required to contract verification services for third-party review of Annual Fuel Pathway Reports and which entities along the fuel supply chain require a site visit.

##### Proposed Solution

Staff proposes to require annual third-party verification of Fuel Pathway Reports to support a new annual reporting requirement proposed in section 95488.10, and to inform CARB's review of ongoing compliance with the certified CI. Verification of temporary CIs or lookup table CIs would not be required.

Fuel pathway holders would be responsible for verification of their Fuel Pathway Reports and, when applicable, verification of other entities in the supply chain that monitor relevant site-specific CI data or who supply specified source feedstock. As part of verification services, fuel pathway applicants must meet requirements for site visits to ensure that reported information and supporting documentation is robust and traced

back to its origin, using a risk based approach. Verification statements would be due to CARB annually by August 31, beginning in 2021.

Staff proposes less frequent third-party verification of annual Fuel Pathway Reports submitted by fuel pathway holders that produce alternative liquid fuel resulting in no more than 6,000 credits during the prior calendar year. Fuel pathway verification statements (and transactions verification statements for alternative liquid fuel production facilities) would be submitted to CARB for all prior unverified reports on August 31 of the year verification is required for the production facility.

#### Rationale Supporting Proposed Solution

Annual third-party verification of operational CI calculations is intended to assure accurate reporting to inform CARB's review of compliance with the certified CI and CARB's review of the validity of prior credits issued.

Staff included an option for less frequent verification for alternative liquid fuel production facilities that generate no more than 6,000 credits, due to the low risk to the LCFS credit market and to manage the costs associated with verification for smaller projects. Smaller projects may also elect to conduct annual verification.

### **Section 95500(c). Verification of Quarterly Fuel Transactions Reports**

#### Description of Problem

To ensure accurate reporting of fuel quantities that result in generation of LCFS credits and deficits, a system to verify accuracy of reported fuel quantities is necessary. CARB must identify which entities are required to contract verification services for third-party review of Quarterly Fuel Transactions Reports.

#### Proposed Solution

Staff proposes to require annual third-party verification by entities reporting the following transaction types:

- Production in California, Production for Import, Import, Export, Gain of Inventory, Loss of Inventory, and Not Used for Transportation for all liquid fuel (alternative and fossil),
- Natural gas and Propane Vehicle Fueling (fossil and renewable-derived), and
- Hydrogen Fuel Cell Electric Vehicle Fueling for hydrogen produced from SMR using pipeline-injected biomethane.

Included in the transactions listed above are fuel quantities using temporary CIs or lookup table CIs. Other transaction types would not be subject to third-party verification. Verification statements would be due to CARB by August 31 for prior calendar year data, beginning with verification statements submitted in 2021 for 2020 data.

This section also includes a less frequent verification schedule for alternative liquid fuel producers who report Quarterly Fuel Transactions and generated no more than

6,000 credits during the prior calendar year. Staff proposes no verification for exporters of small fuel quantities during the prior calendar year—no more than 6,000 credits and no more than 6,000 deficits. Producers and importers that also report exports would have their export transactions verified on the same schedule as their other transactions.

#### Rationale Supporting Proposed Solution

This provision is necessary to detect reporting errors by the first reporting entity that initiates LRT-CBTS reporting for liquid fuels and to require credit adjustments by the initial reporting entity in a timely manner for non-liquid fuels. This is needed to ensure accurate data are relied upon for the generation of credits and deficits under LCFS. Verification of fuel transaction reports is necessary to ensure the accuracy of reported data, which will also result in fewer potential reporting errors upstream of subsequent fuel sales and fewer potential credit adjustments by the initial reporting entity. The transaction types listed in this section are selected as these does not include business partners and therefore not subject to the reconciliation requirements.

Staff included reduced frequency of verifications for alternative liquid fuel producers, entities reporting gain of inventory, entities reporting loss of inventory, and exporters, that meet the 6,000 credit or deficit threshold. This threshold was established on the basis that entities meeting this threshold are considered low risk to the LCFS credit market. Because of the low risk to the LCFS credit market staff considers a reduced frequency of verification to be appropriate.

Staff does not propose less frequent verification for entities that are only importers, or for entities that import any quantity of fuel produced by other parties, as those entities can change business practices to eliminate the verification requirement.

CARB staff does not consider third-party verification necessary at this time for electricity and hydrogen (excluding pipeline biomethane used for SMR). Since electricity and hydrogen for vehicle fueling are expected to primarily be credited through Lookup Table pathways, based on metered data, staff expect data assurance needs will continue to be within the staffing capacity of CARB to conduct periodic compliance audits.

### **Section 95500(d). Verification of Crude Oil Quarterly and Annual Volumes Reports**

#### Description of Problem

For staff's calculation of average crude oil CI used for deficit calculations for all refineries, CARB staff relies on (1) imported crude oil volumes reported annually by California refineries and (2) DOGGR data for crude oil produced in California. Since annual imported crude oil volumes are relevant to deficit calculations by CARB, the data must be accurate. CARB must identify which entities are responsible for contracting verification services for third-party review of Crude Oil Quarterly and Annual Volume Reports.



### Proposed Solution

Staff is proposing annual third-party verification of Crude Oil Quarterly and Annual Volumes Reports for entities reporting crude oil volumes to ensure accurate reporting. This subsection includes a verification deadline of August 31, starting in 2021 for 2020 data.

### Rationale Supporting Proposed Solution

Since crude oil (MCON) volume data are relevant to deficit calculations by CARB and to confirmation of innovative crude credit validity by CARB, it is necessary for these data to be subject to third-party verification to ensure the accuracy and the validity of the reported data. The August 31 verification deadline is necessary for consistency with verification of other LCFS reports.

## **Section 95500(e). Verification of Project Reports**

### Description of Problem

To ensure accurate reporting of the total GHG emission reductions from projects, staff is proposing Project Reports be subject to third-party verification. This will ensure that crediting is appropriate and that project-based crediting under the LCFS can further incentivize real reductions in GHG emissions. CARB must identify which entities are required to contract for verification services for third-party review of Project Reports and which entities require a site visit.

### Proposed Solution

Staff proposes project operators submitting Project Reports and joint applicants be responsible for completing third-party verification, which would include a site visit to the project location, as required in section 95501(b)(3).

Project operators would submit reports for refinery investment projects, for renewable hydrogen projects at refineries and for renewable hydrogen purchased by refineries, and for innovative crude projects. Under this proposal, the project operator would determine whether to submit its report and conduct verification on a quarterly or annual verification cycle starting in 2020, with the option to defer verification when the quantity of requested credits does not exceed 25,000.

### Rationale Supporting Proposed Solution

Third-party verification of Project Reports is needed to ensure that data reported to support the issuance of credits is accurate and complete, and that credit generation is valid. Assigning responsibility for project report verification to project operators and joint applicants is reasonable given that they have the necessary source data and data management systems used for reporting. Flexibility for reporting and verification frequency allows project operators to manage the costs versus benefits of their projects given the number of credits to be issued and the cost associated with verification.

## **Section 95500(f). Verification of Low-Complexity/Low-Energy-Use Refinery Reports.**

### Description of Problem

To ensure accurate calculations of LC/LEU Refinery Credits, staff requires third-party verification of total energy use to determine eligibility and proposes third-party verification of CARBOB volumes or diesel volumes produced from crude oil necessary for the issuance of credits by CARB. Staff relies on the total energy currently reported and verified pursuant to MRR. The volumes of CARBOB and diesel produced and reported in Quarterly Fuel Transactions Reports cannot be used for credit calculation when other feedstocks are used in addition to crude oil.

### Proposed Solution

Staff proposes refinery operators seeking to generate Low-Complexity/Low-Energy-Use Refinery Credits be subject to third-party verification prior to LCFS credit issuance, as described in section 95489(d). Verification statements would be due to the Executive Officer annually by August 31, beginning in 2021 for 2020 data.

### Rationale Supporting Proposed Solution

Third-party verification of Low-Complexity/Low-Energy-Use Refinery Reports is needed to ensure that data reported to support credit issuance are accurate and complete. The August 31 verification deadline is necessary for consistency with verification of other LCFS reports.

## **Section 95500(g). Verification Body and Individual Verifier Rotation Requirements**

### Description of Problem

Individual verifier and firm rotation is needed to maintain verifier independence that, if compromised, could adversely affect the results of the verification opinion.

### Proposed Solution

Staff proposes that entities required to contract for verification ensure that they rotate their verification bodies and individual verifiers after six years of receiving LCFS verification services and ensure a three-year break to reset the timeframe for contracting again with the same verification body or verifiers. Set aside of a positive or qualified positive verification statement based on subsequent errors found would result in a requirement to engage a different verification body but would still allow the prior verification body to continue to provide verification services for the client.

### Rationale Supporting Proposed Solution

Rotation of verification bodies and verifiers is needed to avoid potential conflict of interest issues from lengthy business relationships between verifiers and their clients. This rotation results in a new set of eyes to review the emissions estimates provided by the reporting entity. This requirement will reduce complacency that may occur given the

comfort and familiarity a verification body may feel toward a reporting entity after the six-year time period.

Verification to the standard of reasonable assurance requires the client to clearly describe its data management systems, which are typically updated over time, and requires the verifier to test the effectiveness of data quality control during each verification. Responsible entities can reduce onboarding time for new verifiers by continually improving their documented monitoring plans. CARB staff expects that existing audit firms that would apply for CARB LCFS accreditation would be able to switch clients and effectively bring their knowledge of similar and different data systems to bear during verifications with the new clients.

Staff continues to reach out to potential verifiers to ensure sufficient qualified verifiers are available to provide LCFS verification services and will continue to do so to ensure the number of qualified verifiers and firms does not constrain entities meeting rotation requirements.

## **SECTION 95501. REQUIREMENTS FOR VALIDATION AND VERIFICATION SERVICES.**

### Description of Problem

Since CARB is proposing supplementing the work of CARB staff with a verification system that would include independent third parties engaged by entities reporting to CARB under the LCFS, requirements for rigorous and consistent verification services must be specified.

### Proposed Solution

This section would establish requirements for validation and verification services by verification bodies accredited by CARB. Services would include a verification plan; planning meetings; site visit(s); sampling plan; data checks; required modifications of applications or reports; findings; log of issues; material misstatement assessment; review of measurement accuracy, temporary or alternate methods, and missing data substitution; verification statement; independent review; completion of findings; and verification report.

CARB would oversee the verification program as described in section 95502. This section includes a process for regulated entities to petition the Executive Officer when an adverse verification statement will be submitted by the verifier. Criteria and a process for setting aside positive or qualified positive verification statements when an adverse statement should have been rendered (i.e., CARB finding of a false positive verification statement) are described. Regulated entities and verification bodies would be required to provide information to the Executive Officer within a specified timeframe. Re-verification by a different verification body would be required if a verification statement is set aside.

### Rationale Supporting Proposed Solution

Regulatory requirements for verification services are necessary to ensure consistency of the verification services provided by CARB-accredited verification bodies.

## **Section 95501(a). Notice of Validation or Verification Services**

### Description of Problem

As part of the oversight program, CARB staff needs basic information and sufficient time to plan audits which may include witnessing verifier site visits. Verifiers need to know when they can begin verification services and that their role is not to review data prior to the regulated entity's attestation of the veracity of the information in the application or in the report to CARB.

### Proposed Solution

Staff proposes timing for when the verification body must provide a notice of validation or verification services to the Executive Officer, and when the verification body may begin verification services. Under this proposal, verification services would not begin until the reporting entity attests to CARB regarding the veracity of the data submitted.

Staff also proposes requirements for the types of information to be included in the Notice of Verification Services. Such information would include: a list of personnel conducting verification services, their roles, documentation that the verification team has the necessary skills, and general information on the entity required to contract for verification services. Verification bodies must notify CARB of changes to submitted information.

### Rationale Supporting Proposed Solution

The Notice of Verification Services, including proposed dates, is needed for CARB staff to confirm verifier competency and to plan in advance for any additional oversight of the verification. In some cases, verification services may proceed sooner, such as when CARB does not plan to audit the verification, and a written approval from CARB to begin verification services serves as a record.

The role of verifiers is not to assist the regulated entity in its responsibility to report truthfully to CARB. The role of third-party verifiers is to provide data quality assurance to CARB and create an audit record. Therefore, verification services cannot begin until the veracity of the data submitted to CARB has been attested to by the regulated entity.

## **Section 95501(b)(1). Validation or Verification Plan**

### Description of Problem

The regulated entity needs a general plan from the verification body early in the verification period to understand what will be expected to complete verification services and when the services will be completed. In order for the verification team to establish this general plan, they need preliminary information from the entity being verified to

establish a general understanding of the entity's operations and types of reports subject to third-party verification.

#### Proposed Solution

The verification team would develop a verification plan, which provides documentation of planned activities, site visit(s), and document reviews. The reporting entity's monitoring plan must either include or reference all listed information.

#### Rationale Supporting Proposed Solution

The verification plan is necessary for the verifier and the responsible entity to understand, communicate, and coordinate necessary activities. This initial planning and understanding of the verification services and timelines is important for the entity requesting validation or verification services since the responsibility to meet the verification deadline specified in section 95500 falls on them. In addition, CARB may need to request the verification plan to identify whether the verification body is prepared, understands what is required to complete the validation or verification services, and ascertain the expected timing for completion of the validation or verification. CARB may also use this information to plan for observing audits.

### **Section 95501(b)(2). Planning Meetings with the Entity Required to Contract for Verification Services**

#### Description of Problem

The verification team must discuss with the reporting entity the scope of the verification services and request any information and documents needed for initial validation or verification services.

#### Proposed Solution

The verification team must create a draft risk-based sampling plan and verification plan prior to the site visit. The verification team must also review the documents submitted, and plan and conduct a review of original documents and supporting data for the validation and verification services specified in section 95501(a).

#### Rationale Supporting Proposed Solution

Planning meetings between the verification team and reporting entity serves multiple purposes:

1. The verification team gains a general understanding of the facility operations, staff involved, and data subject to review.
2. Review of supporting documentation provided by the reporting entity allows the verification to develop a draft sampling plan and verification plan.
3. Review of the preliminary verification plan allows entities subject to verification to prepare additional necessary documentation and facility personnel for site visits by third-party verifiers.

### **Section 95501(b)(3). Site Visits**

#### Description of Problem

The locations for site visits and the frequency must be specified, since periodic site visits to the facility or locations of data management are necessary to directly check raw data, data management systems, and make observations of the site, procedures, and personnel.

#### Proposed Solution

Staff proposes all validation and verification services include a mandatory site visit where raw data are acquired or stored. Under this proposal, fuel pathway applicants and fuel pathway holders would require a site visit to the fuel production site and any other locations where site-specific CI data are generated. Entities reporting fuel quantities in the LRT would require a site visit to their recordkeeping location or fuel production facility, as applicable. Lastly, entities reporting projects would require a site visit to the project location. Staff proposes that site visits include a review of supporting documentation, interviews with key personnel, review and understanding of data management systems, review of accounting practices, and assessment of conformance with measurement accuracy requirements.

#### Rationale Supporting Proposed Solution

Site inspection is necessary for the verification team to ensure that the facility process flow diagrams are current and accurate, reported data is substantiated by supporting documentation directly sampled from the data management system(s), FPC allocation methodology and accounting practices for finished fuel conforms to the regulation, record retention practices and data management practices meet the requirements of the regulation, and personnel generating data and reports understand the LCFS reporting requirements.

### **Section 95501(b)(4). Sampling Plan**

#### Description of Problem

To allow for review and oversight, a written sampling plan is needed to document the verifier's initial risk assessment and initial sampling strategy for the verifier to reach reasonable assurance of no material misstatement. When errors are identified, the verifier must be able to modify the sampling strategy in order to finally conclude that the sampling was sufficient to reach reasonable assurance—that if significant errors existed, they were detected.

#### Proposed Solution

Staff proposes the verification team develop the initial sampling plan prior to performing a site visit. The sampling plan is a strategic analysis developed and continually updated based on document reviews and interviews to assess the nature, scale and complexity of the verification services. The sampling plan would include a ranking of risk based on contribution and uncertainty for each data type by report type. It would also include a qualitative narrative of uncertainty risk assessment.

Staff proposes this plan be updated and finalized prior to the completion of the verification services to describe in detail what risks were identified, how the identified risks were addressed during the verification, and the sampling tasks completed by the verification team. The sampling plan would be retained by the verification body for 10 years and made available to CARB upon request. The sampling plan would not be shared with the entity requesting verification services.

For fuel pathway applications and Fuel Pathway Reports that include specified source feedstocks, the verification team would use professional judgment and include in its risk assessment and sampling plan its analysis of the need for a desk review or site visit for verification of any entity in the feedstock chain of custody upstream of the fuel producer to trace feedstock through feedstock suppliers, aggregators, storage or pretreatment facilities, traders or brokers, to the point of origin as required in section 95488.8(g). If an anomaly is detected during data checks of a responsible entity's accounts, the verification team must update its risk assessment and sampling plan to assure specified source feedstock characterization and quantities to the point of origin.

#### Rationale Supporting Proposed Solution

Each responsible entity has unique operations and management systems; therefore, it is necessary for the verification team to exercise professional judgment in choosing source records for review needed to reach reasonable assurance of no material misstatement. Updates to the sampling plan are necessary to document the results of audit trails and whether increased sampling is deemed necessary based on new information. A well-documented sampling plan facilitates independent review by the verification body and by CARB staff. Sufficient detail in the description of data checks is needed so that the independent reviewer and CARB staff can reproduce the findings. The initial and final sampling plans also support CARB's oversight, by providing a means to evaluate the verification team's understanding of the LCFS regulation. Record retention for 10 years is necessary to support CARB investigations and is consistent with other CARB market programs.

### **Section 95501(b)(5). Data Checks**

#### Description of Problem

Data checks are needed to determine the reliability of the submitted data through replicating methods and calculations conducted by the reporting entity.

#### Proposed Solution

Data checks would be required for verifiers to determine reliability of submitted data. The extent of data checks would be based on verifier professional judgement and focus on data with the largest contributions to GHG emissions, including life cycle GHG emissions and reductions, as well as data with the most uncertainty. Data checks would include whether appropriate methods were used, whether the data are sufficiently accurate, and trace submitted data back through any intermediate calculations or summary reports to its origin.

The verification team must compare its own calculated results with the submitted data in order to confirm the extent and impact of any omissions and errors. Any discrepancies must be investigated.

The comparison of data checks must also include a narrative to indicate which data were checked, the quantity of data evaluated for each data type, the percentage of reported source data covered by the data checks, and any separate discrepancies that were identified in the application or report.

#### Rationale Supporting Proposed Solution

Data checks are necessary to determine reliability of the submitted data. Use of verifier professional judgment is needed, as opposed to a statistical sampling, because some data are expected to be more robust or precisely estimated, based on verifier assessment of the responsible entity's unique operations and its management system.

### **Section 95501(b)(6). Application and Report Modifications**

#### Description of Problem

Since reported information must be accurate and complete, and errors may be found during the verification period, a procedure is needed for report correction and final evaluation prior to submittal of the verification statement.

#### Proposed Solution

Staff is proposing to require the responsible entity to fix all correctable errors that affect the fuel pathway application or other submitted report and submit a revised application or report to the Executive Officer prior to the completion of the validation or verification statement. Failure to do so would result in an adverse verification statement. Failure to fix misreported data that do not affect CI, specified fuel transaction data, or projects data would represent a nonconformance with the LCFS regulation but would not, absent other errors, result in an adverse validation or verification statement.

The verification team must use professional judgement in the determination of correctable errors and document the source of any difference identified, including whether the difference results in a correctable error. "Correctable errors" is added as a defined term in section 95481.

#### Rationale Supporting Proposed Solution

The requirement to fix correctable errors and resubmit applications or reports prior to final validation or verification is necessary to ensure CARB receives the most accurate data possible, including fixing small errors that may not lead to material misstatement.



## **Section 95501(b)(7). Findings**

### Description of Problem

Written findings, including the results of independent calculations, are needed prior to rendering a final verification statement.

### Proposed Solution

To assess conformance with the LCFS regulation, the verification team would review the methods and factors used to develop the application or report for adherence to the requirements of the LCFS regulation, identify whether other requirements of the LCFS regulation are met, and document their findings. The verification team would make its own calculations of the data it chose to sample in section 95501(b)(5) to determine there is a material misstatement.

### Rationale Supporting Proposed Solution

Written findings, including the verifier's independent calculations of the data checks in section 95501(b)(5) are needed to assure data quality and support independent review.

## **Section 95501(b)(8). Log of Issues**

### Description of Problem

The entity required to contract for validation or verification needs to understand and address the verification team's findings.

### Proposed Solution

The verification team would keep a written log of any issues identified in the course of validation or verification activities that may affect determinations of material misstatement and nonconformance, whether identified by the verifier, the entity required to contract for verification services, or CARB staff regarding the original or subsequent application or report versions.

The issues log would identify the regulatory section related to the nonconformance or potential nonconformance, if applicable, and indicate if the issues were corrected by the entity required to contract for verification services prior to completing the validation or verification. Any other concerns that the verification team has with the preparation of the application or report must be documented in the issues log and communicated to the entity required to contract for verification services during the course of validation or verification activities.

The log of issues must also indicate whether each issue has a potential bearing on material misstatement, nonconformance, or both and whether an adverse verification statement may result if not addressed.

### Rationale Supporting Proposed Solution

To support management of report modifications needed by the entity required to contract for verification services as well as to support independent review within the

verification body and CARB's targeted audits, a documented log of issues is necessary to track issues discovered during verification services and whether the issues were addressed in the final application or report modification.

### **Section 95501(b)(9). Material Misstatement Assessments for Fuel Pathways and Quarterly Fuel Transactions Reports**

#### Description of Problem

The lead verifier must determine whether he or she is reasonably assured that no errors that would lead to material misstatement exist in the specified data. An equation and threshold must be provided to render this assessment and to help the verifier determine whether additional data checks are needed to identify whether there is a material misstatement.

#### Proposed Solution

The verifier would periodically evaluate the potential for material misstatement during verification services, based on ongoing findings and after report modifications prior to rendering a verification statement. The verification team must attest to reasonable assurance of no material misstatement to issue a positive or qualified positive validation or verification statement, meaning the quality of submitted data is acceptable. Material misstatement assessment is needed to capture discrepancies, omissions, or misreporting (or combination) that lead the verifier to believe that an operational CI is overstated or understated in the fuel pathway application or fuel pathway report by more than 5 percent or by more than 2 gCO<sub>2</sub>e/MJ, whichever is greater.

For Quarterly Fuel Transactions Reports, material misstatement assessment is needed to capture discrepancies, omissions, or misreporting (or combination) that lead the verifier to believe that the reported fuel quantities are overstated or understated by more than 5 percent.

This provision includes equations to assess material misstatement based on the data type for each report type listed: fuel pathway applications, Fuel Pathway Reports, and Quarterly Fuel Transaction Reports. It also provides the data sets on which material misstatement are assessed, and verification outcomes should a verifier indicate a finding of material misstatement.

#### Rationale Supporting Proposed Solution

Verifiers must assess the potential for material misstatement to ensure the data are accurate. The calculation of material misstatement informs the verifier's judgment of data checks needed for different types of data and provides the basis to determine whether they are required to render an adverse verification statement. Staff's proposed 5 percent threshold for material misstatement of operational CIs and quarterly fuel quantities provides for a rigorous assessment consistent with MRR and the Cap-and-Trade Regulation. The 5 percent material misstatement threshold is rooted in financial

auditing and also widely used in other regulatory and voluntary GHG reporting programs.<sup>63, 64</sup>

To reach reasonable assurance verifiers implement a risk-based sampling strategy. An absolute threshold is needed for CI values as they approach zero because at smaller CI values the material misstatement threshold is reduced, which indicates to a verifier that all data used in the calculations would need to be sampled. Staff considers 2 gCO<sub>2</sub>e/MJ sufficiently conservative, and provides an indication to verifiers of an appropriate level of sampling needed across a range of CIs.

### **Section 95501(b)(10). Material Misstatement Assessment for Project Reports (Project-based Crediting)**

#### Description of Problem

The lead verifier must determine whether he or she is reasonably assured that no errors that would lead to a material misstatement exist in the specified data. An equation and threshold must be provided to render this assessment and to help the verifier determine whether additional data checks are needed to identify whether there is a material misstatement.

A review for material misstatement is needed to capture any discrepancies, omissions, or misreporting (or combination) that lead the verifier to believe that the total reported data results in an overstatement greater than 5 percent.

#### Proposed Solution

The verifier must periodically evaluate the potential for material misstatement during verification services, based on ongoing findings and after report modifications prior to rendering a verification statement. The verification team must attest to reasonable assurance of no material misstatement to issue a positive or qualified positive validation or verification statement, meaning the quality of submitted data is acceptable. Material misstatement assessment is needed to capture discrepancies, omissions, or misreporting (or combination) that lead the verifier to believe that the total reported project data results in an overstatement greater than 5 percent.

This provision includes an equation to assess material misstatement, where the verifier would separately assess material misstatement for each project report.

#### Rationale Supporting Proposed Solution

The lead verifier must determine whether he or she is reasonably assured that no errors that would lead to a material misstatement exist in the report. An equation and

---

<sup>63</sup> Climate Action Reserve Verification Program Manual, September 1, 2015, [http://www.climateactionreserve.org/wp-content/uploads/2015/08/Climate\\_Action\\_Reserve\\_Program\\_Manual\\_090115.pdf](http://www.climateactionreserve.org/wp-content/uploads/2015/08/Climate_Action_Reserve_Program_Manual_090115.pdf)

<sup>64</sup> The Climate Registry General Verification Protocol for the Voluntary Reporting Program Version 2.0, June 2010, <http://gicla.org/standards/climate/GHG%20Verifications/7.pdf>

threshold must be provided to render this assessment and to evaluate the extent of data checks needed.

### **Section 95501(b)(11). Material Misstatement Assessment for Low-Complexity/Low-Energy-Use Refinery Data.**

#### Description of Problem

The lead verifier must determine whether he or she is reasonably assured that no errors that would lead to a material misstatement exist in the Low-Complexity/Low-Energy-Use refinery data. An equation and threshold must be provided to render this assessment and to help the verifier determine whether additional data checks are needed to identify whether there is a material misstatement.

A review for material misstatement is needed to capture any discrepancies, omissions, or misreporting (or combination) that lead the verifier to believe that the refinery data is overstated by more than 5 percent.

#### Proposed Solution

The verifier must periodically evaluate the potential for material misstatement during verification services, based on ongoing findings and after report modifications prior to rendering a verification statement. The verification team must attest to reasonable assurance of no material misstatement to issue a positive or qualified positive verification statement, meaning the quality of submitted data meets the standards of the regulation. Material misstatement assessment is needed to capture discrepancies, omissions, or misreporting (or combination) that lead the verifier to believe that the reported Low-Complexity/Low-Energy-Use Refinery Data is overstated by more than 5 percent.

This provision includes an equation to assess material misstatement, where the verifier would separately assess material misstatement for the volume of CARBOB produced from crude oil during a calendar year and for the volume of diesel produced from crude oil during a calendar year. Material misstatement of either submitted value would result in an adverse verification statement for a Low-Complexity/Low-Energy-Use Refinery Report.

#### Rationale Supporting Proposed Solution

The lead verifier must determine whether he or she is reasonably assured that no errors that would lead to a material misstatement exist in the report. An equation and threshold must be provided to render this assessment and to evaluate the extent of data checks needed.

## **Section 95501(b)(12). Crude Oil Quarterly and Annual Volumes Reports**

### Description of Problem

Staff relies on the disaggregated annual crude oil data for its calculation of average crude oil CI used for deficit calculations for all refineries; therefore, verification is needed to ensure entities are reporting in conformance with the regulation.

### Proposed Solution

Consistent with verification under the MRR, staff proposes that verifiers assess whether they have reasonable assurance that reported data conform to the requirements of the regulation, i.e., conformance assessment. Conformance assessment would rely more heavily on assessing the reliability of the procedure for assigning the correct MCON to correct purchased crude oil volumes and less heavily on direct data checks to detect small errors.

### Rationale Supporting Proposed Solution

The verifier must assess reasonable assurance of conformance of reported crude oil data, because the data are relevant to credit and deficit calculations by CARB; however, assessment of material misstatement is not appropriate.

## **Section 95501(b)(13). Review of Missing Data Substitution**

### Description of Problem

Data may be considered invalid or missing based on reasonably anticipated scenarios of monitoring device malfunction as well as events outside the control of the reporting entity. In these cases, entities required to contract for verification services need procedures to omit or replace invalid or missing data that cannot be obtained via transaction counterparties and verifiers need direction on what is required by the regulation to assess errors and possible nonconformances with required methodology.

### Proposed Solution

Data based on transactions between independent parties or based on measurement devices maintained by an independent party, such as feedstock purchases or finished fuel sales, are presumed to be accurate and will not need procedures for determining temporary or alternate measurement methods, quantifying data capture, or substituting missing data, consistent with MRR section 95103(k)(7), since an agreed upon value would be decided by independent counterparties to the financial transaction.

However, data based on internal meters that do not meet accuracy requirements or data that are rendered invalid due to monitoring malfunction or production upsets, must be reported based on an alternate method approved by CARB or based on a temporary method devised by the reporting entity and deemed reasonable by the verifier (i.e., not prone to bias and based on best available data). Data capture requirements and missing data substitution procedures may be specified by CARB on a case-by-case basis in operating conditions for site-specific carbon intensity data and project data. Verifiers would be required to document the date, time and source of missing data;

whether an appropriate method was used; and whether data were calculated correctly according to the allowed method.

#### Rationale Supporting Proposed Solution

The procedure for reviewing invalid or missing data is reasonable and necessary to allow acceptable data to be reported without resulting in an adverse verification statement, while incentivizing proper management of data collection systems.

### **Section 95501(c)(1). Validation or Verification Statement**

#### Description of Problem

A validation or verification statement is needed to allow the verification body to render its conclusions to CARB and the client regarding the conformance of the application or report to the requirements of this subarticle.

#### Proposed Solution

Staff proposes that upon completion of the validation or verification services specified in section 95500, the verification body must submit a validation or verification statement to the entity required to contract for verification services and Executive Officer by the applicable verification deadline specified in section 95500.

Changes to the application or report would not be allowed after the verification statement is submitted to the Executive Officer, unless permitted under the circumstances specified in 95501(e).

#### Rationale Supporting Proposed Solution

This provision is necessary to demonstrate that verification was completed and the verification body has rendered an opinion.

### **Section 95501(c)(2). Independent Review**

#### Description of Problem

CARB requires high confidence in data quality to support CARB's calculation of credits and deficits. Internal objective peer review is considered an international best practice, as indicated in guidance to ISO 14064-3:2006, for validation and verification of greenhouse gas assertions.

#### Proposed Solution

The independent reviewer must serve as a final check on the verification team's work to identify any significant concerns.

The independent reviewer must maintain objectivity by not being involved in the verification services and refraining from making prior or concurrent suggestions about how the validation or verification services should be conducted. The independent reviewer would review documents applicable to the services provided and identify any failure to comply with requirements of the LCFS regulation or with the verification body's

internal policies and procedures for providing verification services. The independent reviewer must concur with the verification findings before the validation or verification statement can be issued.

#### Rationale Supporting Proposed Solution

Independent objective internal review is necessary for consistency with international best practice and to provide confidence in the rigor of verification services and the verification team's findings.

### **Section 95501(c)(3). Completion of Findings and Validation or Verification Report and Statement**

#### Description of Problem

A detailed validation or verification report is needed to serve as a record of the scope of services conducted, findings, and conclusions; therefore, CARB must set minimum verification report requirements for all verifiers.

#### Proposed Solution

The verification body would submit a detailed verification report that includes the verification plan, detailed comparison of data checks conducted, issues log, findings of conformance and nonconformance, material misstatement calculations, and additional documentation specified. The detailed verification report would be retained by the verification body and the reporting entity, but made available to CARB upon request. The verification team would have a final discussion with the reporting entity explaining its findings and any unresolved issues prior to finalizing its validation or verification statement. The validation or verification statement would be submitted to the client and to CARB, and the team lead verifier and the independent reviewer would attest to the conclusions, including explaining associated nonconformances with the regulatory citation in cases of qualified positive or adverse verification statements.

#### Rationale Supporting Proposed Solution

A detailed documentation of the verification services and findings increases confidence that the verification services conducted were thorough and in conformance with the regulation. The verification report should have sufficient detail for CARB or the reporting entity to be able to understand the validation/verification approach taken by the verification team and the depth of the data checks utilized to render a verification statement.

### **Section 95501(c)(4). Adverse validation or verification statement and petition process**

#### Description of Problem

To implement a verification program, CARB needs a mechanism to provide resolution to disagreements on regulatory interpretation between the entity required to contract for verification services and its verification body.

### Proposed Solution

Staff proposes that prior to the verification body submitting an adverse validation or verification statement for the application or report to the Executive Officer, the verification body must notify the entity required to contract for verification services and the entity required to contract for verification services must be provided at least 14 days to modify the application or report(s) to correct any material misstatements or nonconformances found by the verification team. The verification body must provide notice to the Executive Officer of the potential for an adverse validation or verification statement at the same time it notifies the entity required to contract for verification services and include a current issues log with the notice. The modified application or report and validation or verification statement must be submitted to the Executive Officer before the verification deadline.

Requirements for timing of the petition submittal, providing supporting information, and the Executive Officer's final decision are specified.

### Rationale Supporting Proposed Solution

Reporting entities that disagree with the verification body's findings must be provided with a mechanism to request CARB to evaluate the issue and make a final determination. CARB—not verifiers—has the authority to make decisions regarding interpretation of its regulations.

## **Section 95501(d). Validated Applications and Verified Reports Considered Final by the Executive Officer and 95501(e). Set Aside of Validation or Verification Statement**

### Description of Problem

A process to prevent further report corrections after verification, unless specifically required by the Executive Officer, is needed to provide staff time to conduct and conclude investigations and to publish program data on CARB's website.

### Proposed Solution

Reported data would be considered final once a validation or verification statement is submitted to the Executive Officer, except in circumstances where the Executive Officer may set aside a validation or verification statement.

Staff proposes that if the Executive Officer finds a high level of conflict of interest existed between a verification body and a reporting entity, an error is identified, or an application or report that received a positive or qualified positive verification statement fails an Executive Officer audit, the Executive Officer may set aside the positive or qualified positive verification statement issued by the verification body, and require the reporting entity to have the report re-verified by a different verification body within 90 days.



In instances where the Executive Officer determines that an error does not affect the application or report, the change may be made without a set aside of the positive or qualified positive verification statement.

#### Rationale Supporting Proposed Solution

A provision to set aside verification statements as a result of high conflict of interest is necessary to deter high conflict of interest relationships between verifiers and applicants or reporters and to require re-verification by an impartial verification body.

A provision to set aside verification statements as a result of errors identified after a verification statement is submitted to the Executive Officer is necessary to allow for new assessment of risk and sampling strategy with potential for detection of additional errors.

The 90-day timeline of re-verification after a set aside has proven to be sufficient time to contract a different verification body and conduct a new verification, per MRR. Although the set-aside results in a new verification, the documents subject to third-party review are likely largely the same as previously verified, and thus any additional time needed for the reporting entity to prepare for a re-verification is minimal.

### **Section 95501(f). Executive Officer Audits and Data Requests to the Entity Required to Contract for Verification Services, and Section 95501(g). Executive Officer Audits and Data Requests to the Verification Body**

#### Description of Problem

In order to implement CARB's oversight program, staff is proposing provisions to obtain documentation and personnel access for (1) the entities required to contract for validation or verification services, and (2) the verification bodies.

#### Proposed Solution

*Executive Officer Audits and Data Requests to the Entity Required to Contract for Verification Services.* Within 14 days of request by the Executive Officer, the reporting entity must provide the data used to generate the application or report, including all data available to a verifier in the conduct of validation or verification. Furthermore, upon written notification by the Executive Officer, the entity required to contract for validation or verification services and any other entities in the feedstock and finished fuel supply chain, as applicable, must make itself and its personnel available.

*Executive Officer Audits and Data Requests to the Verification Body.* The reporting entity must provide the Executive Officer the validation or verification report given to the entity required to contract for validation or verification services, as well as the sampling plan, contracts for validation or verification services, and any other supporting documents and calculations.

Furthermore, upon written notification by the Executive Officer, the verification body must make itself and its personnel available for an audit by the Executive Officer.

#### Rationale Supporting Proposed Solution

Access to personnel and review of the requested information by the Executive Officer from the entity required to contract for validation or verification services is necessary to provide assurance to CARB that the submitted applications and reports are accurate and well-supported. Access to personnel and review of the requested information by the Executive Officer from the verification bodies is necessary to provide assurance to CARB that the verification team has performed a thorough review of the data and has a good understanding of the regulatory requirements.

### **SECTION 95502. ACCREDITATION REQUIREMENTS FOR VERIFICATION BODIES, LEAD VERIFIERS, AND VERIFIERS.**

#### **Section 95502(a). References to MRR**

##### Description of Problem

CARB is proposing to add a third-party verification program to ensure the quality of LCFS data and oversee the quality and consistency of validation and verification services (herein referred to generically as verification services). Therefore, the proposed regulation includes requirements that potential independent third-party verifiers must fulfill for CARB accreditation to provide LCFS verification services. Staff is proposing LCFS-specific requirements for verifier accreditation that may deviate slightly from MRR, to accommodate the specific education and experience needed to review and verify LCFS data.

##### Proposed Solution

The accreditation process for verification bodies, lead verifiers, and verifiers who plan to provide LCFS verification services is modeled after MRR. Under MRR, verification bodies and verifiers must be accredited by CARB prior to conducting verification services, and must continue to meet accreditation requirements.

Staff is proposing that potential verification bodies and verifiers adhere to the accreditation requirements set forth in MRR sections 95132(b) through (e), except for specific sections referenced in this subsection that are adapted for the LCFS program.

##### Rationale Supporting Proposed Solution

MRR is the State's mandatory GHG reporting program for large emitters, and the data collected under the program supports the framework for the Cap-and-Trade Program and the statewide GHG inventory. MRR was adopted by the Board in 2007 and includes a third-party verification program. Over the course of the program, CARB staff has gained extensive experience in evaluating and training potential verifiers, auditing and overseeing verification bodies, and guiding entities required to contract for verification in the development of their system for preparing for a successful verification.

The proposed third-party verification component of the LCFS regulation seeks to leverage CARB's extensive experience in implementing verification and accreditation programs. While the proposed LCFS verification program is based upon MRR, staff is proposing some modifications from MRR when necessary, including for accreditation.

Both programs are key AB 32 programs to reduce California's GHG emissions; however, the mechanism by which this is achieved differs greatly between the two regulations. MRR quantifies the GHG emissions from specific sources of emissions, whereas the LCFS is tasked with decreasing the CI of California's transportation fuel and providing an increasing range of low-CI and renewable alternatives to conventional petroleum-derived fuels. This is accomplished through the generation of credits and deficits to meet a declining CI standard.

In order to monitor, report, and verify GHG emissions under LCFS, it is necessary to validate initial fuel pathway applications, and also verify the certified CI for each fuel pathway on an ongoing basis. Fuel volumes produced under each fuel pathway must also be verified. The feedstocks for fuels under this program vary greatly, from hydrogen from electrolysis of water, to renewable diesel from the products of rendering, adding further complexity to the verification process. The slight deviations from MRR accreditation program for purposes of LCFS seek to recognize and build expertise in areas specific to the LCFS program.

### **Section 95502(b). Verification Body and Verifier Accreditation Requirements**

#### Description of Problem

Under the proposed regulation, CARB would accredit verification bodies, lead verifiers, and non-lead verifiers, including independent reviewers, to provide LCFS verification services.

#### Proposed Solution

The regulation specifies the application requirements to assess verifier eligibility and whether they meet the minimum standards required in this section. During the accreditation application process, candidate verification bodies would submit documentation for CARB review and approval, showing that they meet the requirements for accreditation as delineated in the MRR, along with those requirements specific to the LCFS regulation.

CARB proposes to require an application process to review qualifications prior to accrediting potential verification bodies and verifiers. The application process will ensure that CARB can assess that the potential candidates meet the minimum criteria in the regulation to become LCFS-accredited verifiers.

#### Rationale Supporting Proposed Solution

To ensure that sufficient training for verifiers conducting verification services is occurring and ongoing, staff is asking the verification body to provide documentation to the

Executive Officer showing that it has procedures and policies to support staff technical training as related to validation or verification.

### **Section 95502(c). Verifier Competency Requirements**

#### Description of Problem

Staff is proposing third-party verification of data submitted under LCFS and must specify the minimum competency requirements to obtain CARB accreditation and provide LCFS verification services.

#### Proposed Solution

Per MRR, the proposed regulation maintains the requirement that verifiers meet minimum educational and experience requirements and submit documentation to that effect.

Staff is proposing two levels of verification training, one being a CARB-approved comprehensive general verification training and examination, and one a subset of the comprehensive training program, consisting of a CARB-approved LCFS-specific training program. Potential lead verifiers demonstrating their understanding of general GHG emissions quantification and monitoring principles would need only LCFS-specific training. This demonstration can be fulfilled by having met at least one of the following criteria: participated within the previous two years on a verification team in a minimum of three completed LCFS validations or verifications with the supervision of a CARB-accredited lead verifier; be a CARB-accredited lead verifier under MRR or Cap-and-Trade Regulations; be approved to conduct attestation engagements under the U.S. EPA RFS program or U.S. EPA RFS QAP service teams within the previous two years or currently team lead; or lead on biofuels certification audit in the previous two years or acting as lead under the International Sustainability and Carbon Certification (ISCC), Roundtable on Sustainable Biomaterials (RSB), or Bonsucro.

Verifiers who have worked as a project manager or lead person in a GHG program area for no less than four years, of which two may be graduate level work, have not demonstrated their understanding of general GHG verification, and are therefore required to take the CARB-approved comprehensive general verification training and examination, which includes the LCFS-specific training program.

A lead verifier for fuel pathway applications or reports must also have experience in alternative fuel production technology and process engineering. A lead verifier for Quarterly Fuel Transactions Reports, Crude Oil Quarterly and Annual Volume Reports, and Project Reports must be accredited as an oil and gas system specialist as defined in MRR.

#### Rationale Supporting Proposed Solution

Because of the complexities that validation and verification of GHG emissions present, it is general practice to pre-screen applicants to confirm that they demonstrate basic

educational and work skills to successfully complete the CARB LCFS training and subsequently provide validation and verification services.

Certain verifiers already accredited under other approved programs would be allowed to take an abbreviated training course to learn the LCFS program and how to apply verification principles and requirements under the program. Lead verifiers without experience under other approved programs specified in the proposed regulation would be required to take the full suite of training provided by CARB for accreditation, including general training.

Staff is including specific provisions to ensure a sufficient number of qualified verifiers will be in the program at the outset. Since most of the regulated entities subject to LCFS requirements are also subject to the RFS, CARB staff expects the auditing firms contracted to conduct RFS attestation engagements and QAP audits to be well qualified for, and interested in seeking, LCFS accreditation. In addition, verifiers accredited under CARB's existing verification programs have relevant training and experience to conduct GHG verifications, and would only be required to complete training pertaining to the LCFS program requirements. This is intended to streamline the implementation of the LCFS verification program.

GHG verifiers conducting audits in cooperation with select international biofuel certification systems are considered to have the comprehensive general GHG verification experience needed to pursue CARB accreditations under the LCFS-specific training option, rather than needing to undergo the comprehensive general verification training and examination program. This is an option that will fast-track international verifiers and help fuel producers outside the U.S. obtain CARB-accredited LCFS verifiers.

Staff is also proposing that accreditation as a lead verifier for validation of fuel pathway applications or verification of Fuel Pathway Reports require the verifier to have experience in alternative fuel production technology and process engineering. This requirement is included because verification of these components of the LCFS program requires a strong understanding of life cycle analysis for CI, along with an understanding of biofuel production processes, which are often complicated and involve many different feedstocks and chemical processes. This requirement is analogous to the sector-specific requirements in MRR.

Staff is also proposing that a lead verifier for verification of Quarterly Fuel Transactions Reports from fuel producers and importers of gasoline or diesel, Crude Oil Quarterly and Annual Volume Reports and Project Reports must be oil and gas system specialists as defined in MRR. These fuels are deficit generating and their production is complex; therefore, we believe it is necessary that a verifier in these sectors have additional sector-specific experience and knowledge as per MRR for a complete and accurate accounting of deficits generated.

## **SECTION 95503. CONFLICT OF INTEREST REQUIREMENTS FOR VERIFICATION BODIES AND VERIFIERS.**

### **Section 95503(a). Applicability of Conflict of Interest Provisions**

#### Description of Problem

To ensure a rigorous and effective verification program, CARB must specify and oversee monitoring and disclosure requirements for potential conflicts of interest (COI) between verifiers and their clients (LCFS regulated entities). These requirements include the reporting of incompatible activities by verifiers and mitigation measures when applicable. CARB must also specify the consequences for nondisclosure and insufficient avoidance and mitigation of potential COIs.

#### Proposed Solution

This provision specifies the entities subject to the COI provisions, describes the COI requirements such that verification bodies and individual verifiers can determine and disclose to CARB their conflict of interest level, and includes a requirement that verification bodies describe actions taken to avoid, neutralize, or mitigate any ongoing potential for COI.

This section includes a list of activities where potential for COI is high and, as a result, verification services would not be allowed. Also specified are criteria for low and medium potential COIs, a description of the process for monitoring and disclosing COIs, the timeframe prior to verification services that must be included in these assessments, and the timeframe for monitoring COI after verification services have been completed.

In regard to the timeframe prior to the start of verification services for the verification body to assess the potential for COI – also known as the “lookback period” – staff has included a phase-in process. Prior to January 1, 2022, some services considered high COI will be considered medium COI during the five-year lookback period prior to the start of verification services. January 1, 2022, will mark the date whereby there are no exceptions to activities considered high COI during the five-year lookback period. High COI activities will then trigger the provision calling for rotation of verification bodies. The provisions also describe consequences for later discovery that a high potential for a conflict of interest existed during verification services.

The verification body is proposed to be responsible for assessing COI and submitting its assessment to CARB for review, because it will have information on its related entities, which would be included in the assessment for high COI potential.

#### Rationale Supporting Proposed Solution

This section will serve to protect audit quality via assurance of verifier, regulated entity, and contractor objectivity and independence. Monitoring and assessing potential COI is recognized as necessary for confidence in audit rigor under international GHG verification standards and public financial accounting standards. As a matter of common business practice, firms that conduct audits have procedures for monitoring and

assessing conflict of interest with potential clients before they engage in contracts for auditing or other services. However, it is incumbent upon CARB to ensure that specific minimum criteria for assessing conflict of interest are met. Therefore, CARB must specify a timeframe for assessing, proposing mitigation, and disclosing potential COI, including the initial starting date based on the effective date of the regulation.

These COI provisions are also necessary to establish requirements, responsibilities, mitigation, monitoring and assessment by verification bodies, and oversight by CARB. They also describe the consequences of failing to abide by the COI provisions.

### **Section 95503(b). Disclosure of Services with High Potential for Conflict of Interest**

#### Description of Problem

CARB must ensure that verification does not proceed under a COI, whether real or perceived. Staff is proposing that verification services would not be allowed if the potential for COI is high. Therefore, the regulation must specify the services that would be considered high COI during the lookback period and, as a result, prohibited if conducting an LCFS verification.

#### Proposed Solution

The proposed regulation includes prohibitions such as providing services that would be considered verifying one's own work, advocating for the client, advising the client on compliance strategies, or having a commercial or financial interest in verification outcomes.

#### Rationale Supporting Proposed Solution

Specifying prohibited activities is necessary to verification bodies and their potential verification clients to assess whether verification would be allowed by CARB and what consequences may result if high conflict was later discovered. The rationale for specific types of high conflict of interest are discussed further in the rationale for sections 95503(b)(1) through (b)(4) below.

Because third-party verification is a new component of the LCFS regulation, potential verifiers may have participated in activities prior to adoption of the third-party verification program that would be considered high COI. Without a phase-in period these verifiers would be prohibited from offering verification services.

In order to assure a sufficient supply of verifiers, staff has incorporated a phase-in of certain high COI conditions. Under the phase-in, some services considered high COI will be considered medium COI during the lookback period. This provision will allow potential verification bodies that were not aware of the upcoming CARB requirements to provide verification services in the early years of the verification program. Staff believes these specific activities pose less risk to impartial verification if limited to the phase-in period. CARB staff will provide additional oversight to confirm that mitigation plans submitted under the phase-in are sufficient.

## **Section 95503(b)(1). Organizational High Potential Conflict of Interest Conditions**

### Description of Problem

The proposed regulation classifies shared management or common members of the boards of directors as a high COI, since they would be responsible to the verification body and the regulated entity.

### Proposed Solution

This provision describes a high COI condition between the verifying body and the entity required to contract for verification services, where senior management have been employed or served on the board of directors of the verifying body and entity required to contract for verification services.

### Rationale Supporting Proposed Solution

There may be a business interest that could affect the verification outcome if the verification body and the entity required to contract for verification services shared senior management of board of directors. Therefore, it is necessary to identify organizational conflict of interest to maintain independence between the two entities to ensure impartiality.

## **Section 95503(b)(2). Organizational and Individual High Potential Conflict of Interest Conditions**

### Description of Problem

CARB must ensure that verification does not proceed under a conflict of interest, whether real or perceived. Staff is proposing that verification services would not be allowed if the potential for conflict of interest is high, therefore, the regulation must specify the services that would be considered high during the lookback period and prohibited for conducting a potential LCFS verification.

### Proposed Solution

This provision describes high COI conditions where an employee of the verification body, an employee of an entity related to the verification body, or a verification team subcontractor has provided services listed as incompatible with objective, independent verification.

### Rationale Supporting Proposed Solution

Prohibition of incompatible activities is necessary to maintain audit quality via objectivity and independence resulting in confidence in the rigor of verification services.



### **Section 95503(b)(3). Prohibition on Monetary or Non-Monetary Incentives**

#### Description of Problem

CARB must ensure that verification does not proceed under a conflict of interest, whether real or perceived. Staff is proposing that verification services would not be allowed if the potential for conflict of interest is high, therefore, the regulation must specify the services that would be considered high during the lookback period and prohibited for conducting a potential LCFS verification.

#### Proposed Solution

This provision describes a high conflict of interest potential when there have been incentives (monetary or non-monetary) provided by the verification body to the entity required to contract for validation or verification services to secure a validation or verification contract or provided by the entity required to contract for validation or verification to the verification body to influence verification outcomes.

#### Rationale Supporting Proposed Solution

Prohibition on monetary and non-monetary incentives is necessary to maintain audit quality via independence and have confidence in the rigor of verification services.

### **Section 95503(b)(4). Potential for High Conflict of Interest if Rotation Limit Exceeded**

#### Description of Problem

CARB must ensure that verification does not proceed under a conflict of interest, whether real or perceived. Staff is proposing that verification services would not be allowed if the potential for COI is high, therefore, the regulation must specify the services that would be considered high during the lookback period and prohibited for conducting a potential LCFS verification.

#### Proposed Solution

This provision establishes that a high potential for conflict of interest occurs when a member of the verification body or team has provided LCFS verification services for the entity required to contract for verification services for more than 6 consecutive years. See section 95550(g) – Verification Body and Verifier Rotation Requirements.

#### Rationale Supporting Proposed Solution

The verification bodies and members of teams may not provide services outside the verification body rotation requirements in order to avoid compromising the verification body's or verifier's impartiality. See extended discussion under section 95500(g).

### **Section 95503(c). Low Conflict of Interest**

#### Description of Problem

Since CARB would oversee verification services, low potential for COI must be defined.

### Proposed Solution

If there are no high COI issues identified pursuant to section 95503(b), a test of financial interest would have applied to determine whether an assessment of low or medium COI would result, consistent with MRR. Audit services that require independence would be disclosed, but not included in the revenue assessment.

### Rationale Supporting Proposed Solution

This provision is necessary to define conditions describing low potential for COI, under which mitigation and Executive Officer approval would not be required prior to the start of verification services. It is necessary to establish a threshold on revenue received from a single client for services that do not require independence relative to the value of LCFS verification services to assess whether the quality of verification services could be or perceived as compromised due to financial interest.

## **Section 95503(d). Medium Conflict of Interest**

### Description of Problem

Since CARB would oversee verification services, medium potential for COI must be defined, in addition to high and low COIs. Many verifications would be expected to be assessed as low potential for COI because many audit firms specialize in auditing, a service which inherently seeks to avoid COIs. However, larger firms typically offer multiple types of services and need an option that could mitigate potential for COIs.

### Proposed Solution

A medium conflict of interest would be found when potential for conflict of interest is not determined to be either high or low per provisions in section 95503(b) and 95503(c). Potential for medium conflict of interest would require the verification body to submit a mitigation plan to CARB for review and approval. Typically, employees and their management participating in verifying the client's reports would be segregated from other staff and management providing other services which are not considered high conflict. Confidentiality would also be maintained between the groups.

### Rationale Supporting Proposed Solution

Actions to mitigate medium potential for conflict of interest are necessary so that independent verification services can be provided. The Executive Officer must independently evaluate whether the mitigation is sufficient.

## **Section 95503(e). Conflict of Interest Submittal Requirements for Accredited Verification Bodies**

### Description of Problem

Since verification bodies would be required to self-assess potential conflict of interest, requirements for submission of a self-evaluation of the potential for COI to the Executive Officer must be specified.

### Proposed Solution

COI submittals by verification bodies very closely mirror requirements under MRR. Prior to providing verification services the verification body must be authorized by the Executive Officer. In order to obtain this authorization, the verifying body would need to submit a self-evaluation. The LCFS regulation incorporates the submittal requirements from MRR section 95133(e) through (g), with the exception of two LCFS-specific COI provisions. These MRR sections detail the assessment and disclosure process a verification body would need to follow in order to provide verification services. Verification bodies would disclose and attest to their self-assessment of COI and await CARB authorization prior to conducting verification services unless their self-assessment indicates a low potential COI, in which case they may conduct verification services prior to receiving EO approval. In addition, they would continue to monitor the potential for COI.

### Rationale Supporting Proposed Solution

Executive Officer evaluation of COI assessment submittals and authorization prior to commencement of verification services is needed to ensure that verification services do not occur when there is high potential COI or insufficiently mitigated medium potential for COI, since verifier impartiality, objectivity, and independence is required to maintain confidence in the rigor of verification services.

## **13 CCR SECTION 2293.6. IN-USE REQUIREMENTS FOR SPECIFIC ADFS SUBJECT TO STAGE 3A.**

### Description of the Problem

The current ADF regulation sunsets biodiesel in-use requirements when 90 percent of the vehicle miles travelled by the California on-road heavy-duty diesel vehicle fleet is determined to be from on-road heavy-duty New Technology Diesel Engines (NTDE) in California. As part of the program review of in-use diesel requirements required in section 2293(6)(A), staff re-examined off-road emissions. Based on additional off-road data, staff determined that the current sunset provision would potentially result in NOx increases, based on the analysis in the supplemental disclosure discussion document in Appendix G to this Staff Report. More information on the data and analysis is available in Appendix G.

The current ADF Regulation also includes a limited producer/importer exemption. The exemption has not been used and the application deadline has passed.

### Proposed Solution

Staff proposes to add an additional requirement to the sunset provision of the ADF regulation such that the ADF sunset would not occur until the hours of operation of off-road NTDEs are 90 percent of the total hours of operation of off-road diesel engines. This is in addition to the current provision requiring 90 percent of vehicle miles travelled by on-road heavy-duty diesel vehicles to be from on-road heavy-duty NTDEs. Staff will consider whether the sunset provision can be bifurcated for on-road vehicles versus off-road vehicles and equipment, which would result in an earlier anticipated sunset date

for on-road vehicles, but is not proposing that solution in this draft due to concerns about potential implementation issues.

Staff also proposes to remove the limited producer/importer exemption, and all related language, from the ADF regulation as the cut-off date for applications has passed and no applications were received.

#### Rationale Supporting the Proposed Solution

The inclusion of off-road diesel engines in the sunset calculation ensures NOx emissions from all diesel-fueled mobile sources are considered and that the sunset implementation is expected to have no annual NOx emission increases.

The removal of the limited producer/importer exemption removes unnecessary language.

### **13 CCR Section 2293. Appendix 1 of Subarticle 2. In-use Requirements for Pollutant Emissions Control**

#### Description of the Problem

The Appendix contains two transcription errors. The range viscosity for biodiesel reference fuels described in Table A.8 was incorrectly listed as 2.0 to 4.1, which is the proper range for diesel, not biodiesel blendstocks. The maximum polycyclic aromatic hydrocarbon content for the reference diesel described in Table A.9 was incorrectly listed as 10 percent, which is the appropriate value for total aromatic hydrocarbon content.

#### Proposed Solution

Staff proposes to change the range for viscosity of biodiesel reference fuels to 1.9 to 6.0, which is the appropriate range for biodiesel blendstocks per ASTM D6751. Staff also proposes to change the maximum polycyclic aromatic hydrocarbon content to 1.4 percent to match the value used in 13 CCR section 2282 (g).

#### Rationale Supporting the Proposed Solution

These values were improperly recorded due to transcription error when the regulation was originally adopted. This action will correct that error.

#### **IV. BENEFITS OF THE PROPOSED AMENDMENTS**

CARB anticipates that the proposed amendments will have the following general benefits to California businesses and individuals:

- Reduced greenhouse gas (GHG) emissions. The LCFS is specifically designed to reduce GHG emissions in the transportation sector, which is responsible for nearly half of GHG emissions in California. This will contribute to California's efforts to achieve its mid- and long-term climate goals. By incentivizing the development and adoption of innovative low carbon fuels, the more aggressive targets will facilitate greater reductions in the future.
- Reduced criteria pollutant and toxic air contaminant emissions. Increased use of lower CI alternative fuels and alternative fueled vehicles including biodiesel, renewable diesel, renewable jet fuel, low NO<sub>x</sub> natural gas trucks, and electric and hydrogen zero emission vehicles. In addition to reducing GHG emissions, this may lower levels of localized air pollutants, which are the cause of many deleterious health effects on California residents.
- Greater opportunities for California businesses to invest in the production of alternative fuels and other credit generating opportunities at oil fields and refineries.
- Reduced dependence on fossil fuels and crude oil imports and diversification of the transportation fuel pool, which may decrease the exposure of California to large swings in energy prices due to external economic shocks. The LCFS increases the cost of fossil fuels relative to low-carbon fuel options, such as electric vehicles, renewable diesel, and biomethane. As low-carbon, non-conventional fuels become lower-cost fuel options, demand for fossil fuels will be reduced.

In the following sections, staff describes the estimated benefits of the proposed amendments to California businesses and individuals.

##### **A. Reduced GHG Emissions**

Since 2011, the LCFS regulation has required reductions in the carbon intensity of transportation fuels used in California. As a result of these requirements, GHG emissions have been reduced from the production and use of transportation fuel in California. The proposed LCFS amendments includes strengthening the CI reduction targets through 2030 in-line with California's 2030 GHG reduction requirement enacted through SB 32.

As discussed in the economic analysis section of this document, staff conducted an in-depth scenario analysis that informed possible compliance schedules through 2030. Staff developed modeling tools that take into account feedstock supply, fuel prices, fuel incentives, and capacity constraints to assess the technical and economic feasibility of bringing low carbon fuels to California. Staff used these modeling tools, together with input from stakeholders and supply projections from subscription services such as

Bloomberg New Energy Finance and Lux Research, to assess fuel supply variability and sensitivity to LCFS credit price and other uncertain market effects on a year-by-year basis. The section describes the GHG benefits of the primary compliance scenario considered.

As the proposed amendments retain the market flexibility of the current LCFS, it is not possible to predict the exact path or fuels used for future compliance. Therefore, the projected fuel volumes and associated benefits described in this chapter should be considered as illustrative only.

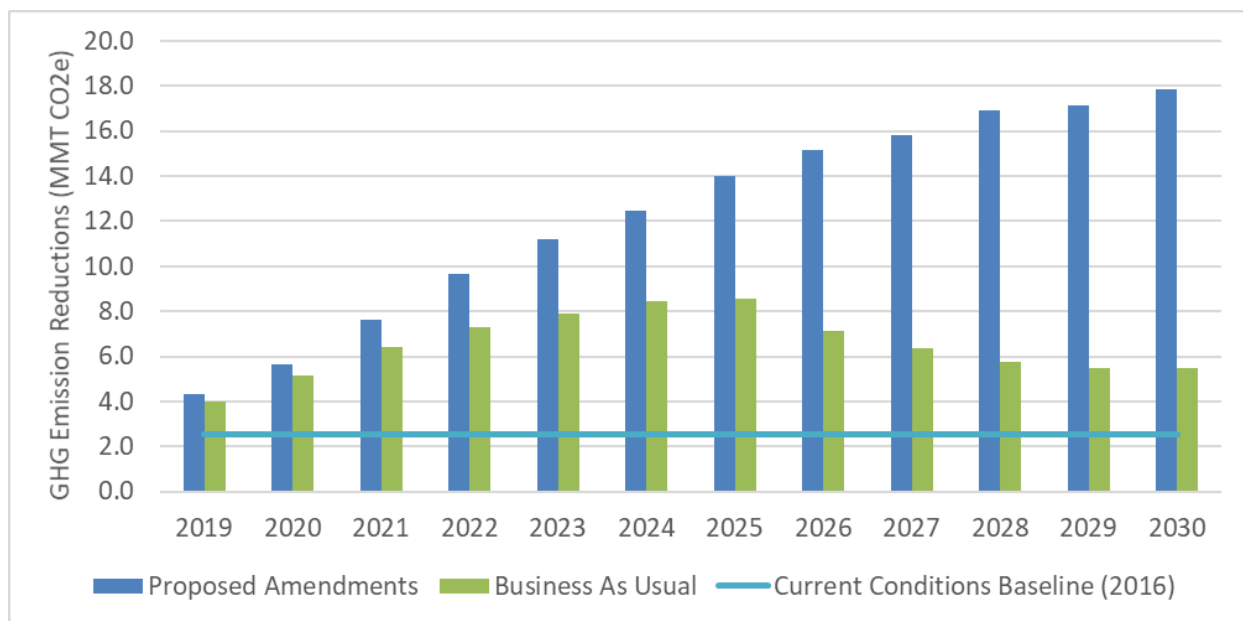
The proposed reduction in the CI of the transportation fuel pool is expected to result in annual GHG emissions reductions as shown in Figure IV-1. It is important to note that, because the LCFS calculates emission reductions on a full life cycle basis, the GHG emission reductions occur both in California and out-of-state. These GHG reduction estimates include an adjustment to eliminate double counting of emission reductions that are attributed to other State and federal programs such as Advanced Clean Cars and the Renewable Fuel Standard as well as rebate programs for zero emission vehicles. Details on the methodology staff used to attribute GHG emission reductions to the LCFS versus other programs are presented in Appendix F.

Also shown for comparison are the annual GHG emission reductions attributable to the LCFS for the “current conditions” baseline (i.e. year 2016)<sup>65</sup> and the “business-as-usual” scenario. The business-as-usual scenario represents compliance with the current regulation in which the proposed amendments are not adopted and the current ten percent CI reduction target continues unchanged from 2020 through 2030. For this scenario, GHG emissions attributable to the LCFS decline after year 2025 as overall gasoline demand decreases and EV adoption increases. As overall gasoline demand decreases, total credits (i.e. GHG reductions) necessary for compliance with the fixed 10 percent reduction target also decline. In addition, the increase in EV adoption results in more credit generation by electricity. Because GHG emission reductions associated with charging EVs with grid electricity are not assumed to be attributable to the LCFS, the increase in credit generation by EVs results in a further decline in GHG emissions attributable to the LCFS for this scenario.

---

<sup>65</sup> GHG emission reductions attributable to the LCFS in year 2016 are estimated to be approximately 2.6 MMT CO<sub>2</sub>e.

**Figure IV-1: Estimated LCFS GHG Emission Reductions for 2019 to 2030 Attributable to the LCFS (MMT<sub>CO2e</sub>)**



Cumulatively from 2019 through 2030, the proposed amendments provide an additional 117 MMT emission reductions as compared to the current conditions baseline and an additional 70 MMT emission reductions as compared to the business-as-usual scenario.

## **B. Reduced Criteria Pollutant and Toxic Air Contaminant Emissions**

Improvements in California air quality under the proposed amendments are anticipated to result in health benefits for California individuals. These health benefits include reduced cardiopulmonary mortality, hospitalizations for cardiovascular illness, hospitalizations for respiratory illness, emergency room (ER) visits for respiratory illness, and ER visits for asthma. The proposed amendments will affect air quality through three main categories: 1) tailpipe emissions for on-road and off-road vehicles, 2) aircraft emissions at airports, and 3) changes in emissions at stationary sources from fuel production and steam production at oil fields.

Staff estimates reductions in tailpipe emissions of NO<sub>x</sub> and PM<sub>2.5</sub> throughout the State due to increased use of diesel alternatives. Reductions in emissions of NO<sub>x</sub> and PM<sub>2.5</sub> are also expected to occur in areas surrounding airports due to the switch to alternative jet fuels. Additionally, individuals living close to oil fields in the San Joaquin Valley may experience improved air quality, as solar power may be substituted for combustion of natural gas in steam generators. Small emission increases may occur near rail tracks and terminals, fuel blending facilities, and biofuel production facilities, including facilities that produce electricity, hydrogen, dairy digester gas, cellulosic ethanol, renewable diesel, and alternative jet fuel. Potential emission increases near production facilities are estimated to be very small relative to total emission reductions from tailpipe, jet fuel, and solar steam. When considering the net effect at the California air basin level, the

proposed amendments are estimated to result in a significant net decrease in emissions from 2018 through 2030, with all air basins experiencing net health benefits. Chapter V provides a detailed summary of the air quality and health impacts of the proposed amendments.

### **C. Greater Opportunities for California Businesses to Invest in Low Carbon Transportation Technologies**

The proposed amendments will increase the demand for low carbon fuels, which provides an opportunity for businesses, both in-state and out-of-state, to increase revenue from the sale of low carbon fuels in California. The sale of LCFS credits provides an additional revenue stream for these firms, enabling them to increase their market share and increase their competitiveness against high-CI fuels such as fossil gasoline or diesel. Moreover, firms that are early investors in innovative, low-CI fuel technologies may be at a competitive advantage if other state, federal, or international jurisdictions adopt similar carbon intensity standards.<sup>66</sup> A detailed discussion of the economic impacts of the proposed amendments is provided in both Chapter 8 and Appendix E.

The proposed amendments may also lead to a higher long-run price for LCFS credits relative to business-as-usual, which will send a signal for research and development, and deployment of innovative technologies and fuels that support California's long-term GHG emissions reduction goals. All fuel producers will have an increased incentive to innovate and deploy new methods that reduce the CI of their fuels. The proposed amendments will additionally provide long term price stability for LCFS credits, which is essential for low-CI fuel producers to make investments in long-term capital projects and research and development. Some of the innovations staff is expecting to see in the next five to ten years include:

- Implementing processes that substitute low carbon sources of process energy, such as residual biomass, renewable natural gas and renewable electricity, in place of fossil fuel sources.
- Producing cellulosic ethanol from residual corn kernel fiber and sugarcane bagasse at conventional corn and sugarcane ethanol facilities, thereby improving production yields and energy efficiency.
- Deployment of advanced EV charging and hydrogen production technologies that take advantage of intermittent renewable power generation to lower CI scores.
- Producing solar-generated steam in place of fossil-generated steam at oil fields for thermally enhanced oil recovery.

Additionally, the proposed amendments include a protocol that will pave the road for CCS projects, a technology area with a high potential for innovation and development.

---

<sup>66</sup> Currently both Oregon and British Columbia have LCFS-like policies in place and both Canada and Brazil are considering similar policies.



Studies by the Intergovernmental Panel on Climate Change<sup>67</sup> and the California Council on Science and Technology<sup>68</sup> have shown that CCS has the potential to reduce carbon emissions by millions of metric tons, and may be an integral part of meeting long term climate goals. The ability to earn LCFS credit for CCS projects will provide a very significant incentive to businesses to invest in CCS projects within the transportation fuels sector and to demonstrate this technology.

Finally, the proposed amendments expand the scope of the regulation to additional fuels that are exempt under the current regulation, including alternative jet fuels (AJF). In addition to GHG and criteria pollutant reductions, including AJF may have economic benefits. Because AJF and renewable diesel (RD) are often produced in the same facility using the same feedstock, inclusion of AJF may lead to increased investment in facilities, thereby increasing the production of both alternative fuels. The airline industry is developing a strong record for partnering with alternative fuel producers through direct investment and off-take agreements,<sup>69</sup> which provide the certainty necessary to get these advanced biofuel facilities built.

#### **D. Reduced Dependence on Fossil Fuels**

The proposed amendments will create strong incentives to use low-carbon fuels that help displace conventional fossil fuels by 2030. Low-carbon fuels include electricity and hydrogen, as well as renewable diesel, biodiesel, and ethanol. As regulated parties seek to comply with the LCFS, alternative fuels will increasingly enter California's fuel market. The proposed amendments will also help motivate process changes, such as substituting biomethane for natural gas, the use of solar steam rather than natural gas-generated steam for oil recovery, and the use of renewable propane instead of conventional propane in vehicles.

Compared to the business-as-usual scenario, the proposed amendments are expected to primarily drive increased use of alternative fuels for heavy-duty vehicle applications displacing CARB diesel. Annually, almost 900 million GGE of fossil fuels are expected to be displaced as part of compliance with the LCFS under the proposed amendments by 2030.

As California has a variety of other programs that more directly help promote the use of zero emission technology in light-duty vehicles and reductions in VMT, the LCFS (and thus the proposed amendments scenario) are not assigned the benefits of this CARBOB displacement from the use of these low carbon fuels. However, the proposed

---

<sup>67</sup> IPCC Special Report. Carbon Dioxide Capture and Storage. <http://www.ipcc.ch/report/srccs/>.

<sup>68</sup> CCST Publications. Policies for California's Energy Future – Electricity from Natural Gas with CO<sub>2</sub> Capture for Enhanced Oil Recovery. <http://ccst.us/publications/2015/2015ccs.php>.

<sup>69</sup> CARB staff presented an evaluation of inclusion of jet fuel at a public working meeting on March 17, 2017. See Slides 27 and 28 at the following link for a list of examples: [https://www.arb.ca.gov/fuels/lcfs/lcfs\\_meetings/031717presentation.pdf](https://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/031717presentation.pdf).

LCFS amendments help reduce compliance costs for such programs, and promote the construction of ZEV fuel infrastructure, which may promote additional use of ZEVs in the California market.<sup>70</sup>

Additional reductions in fossil fuel use also occur for gaseous fuels due to use of renewable propane, and for jet fuel due to expansion of the LCFS to credit alternative jet fuel under the proposed regulation. Compared to business-as-usual, which does not credit renewable propane or alternative jet fuel, the proposed amendments are estimated to result in an additional 340 million GGE of fossil fuels to be displaced.

---

<sup>70</sup> This is not assigned to the LCFS for simplicity (and to provide alignment between CARB analytical exercises) but various levels of ZEV penetration is considered as a sensitivity in staff's analysis.

## V. AIR QUALITY

This chapter summarizes the potential air quality and public health impacts in California related to increased production and consumption of alternative fuels, changes in feedstock sources, and implementation of carbon capture and sequestration (CCS) and petroleum-based projects that are driven by the LCFS in response to the proposed amendments.

Below are descriptions of the pollutants of interest in this chapter.

- Criteria Air Pollutants: Criteria air pollutants are determined to be hazardous to human health and are regulated under U.S. EPA's National Ambient Air Quality Standards. The 1970 amendments to the Clean Air Act require U.S. EPA to describe the health and welfare impacts of a pollutant as the "criteria" for inclusion in the regulatory regime. Both the California and federal governments have adopted health-based standards for the criteria pollutants that include ozone, particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>), carbon monoxide (CO), oxides of nitrogen (NO<sub>x</sub>), oxides of sulfur (SO<sub>x</sub>), and volatile organic compounds (VOC).
- Toxic Air Pollutants: Toxic air pollutants (also referred to as toxic air contaminants [TAC], or air toxics) are those pollutants which may cause or contribute to an increase in mortality or serious illness, or which may pose a hazard to human health but are not regulated as criteria pollutants. Air toxics are usually present in minute quantities in the ambient air. However, their high toxicity or health risk may pose a threat to public health even at very low concentrations. The toxic air pollutant of most concern in this analysis is the particulate matter from diesel-fueled heavy-duty trucks (diesel PM).

In this chapter, staff first provides an overview of the air quality analysis and major air quality findings in section A. Next, in section B, staff presents baseline conditions for the analysis including fossil and alternative fuel volumes and estimated emissions for existing California fuel production facilities and mobile sources. Following this discussion, in section C, staff provides a description of staff's Illustrative Compliance Scenario, which focuses on the major changes from the baseline condition. In section D, staff describes the changes of emissions relative to the baseline, including tailpipe emissions from use of biodiesel and renewable diesel, alternative fuel production emissions, petroleum-based project emissions, and aviation emissions from use of alternative jet fuel (AJF). Staff then describes the health impacts analysis for NO<sub>x</sub> and PM emission changes in Section E. In Section F, staff describes the health risk assessment for a potential California biofuel facility. Finally, staff gives a brief summary in section G of a similar analysis performed using a business-as-usual scenario where the LCFS remains at 10 percent post 2020.

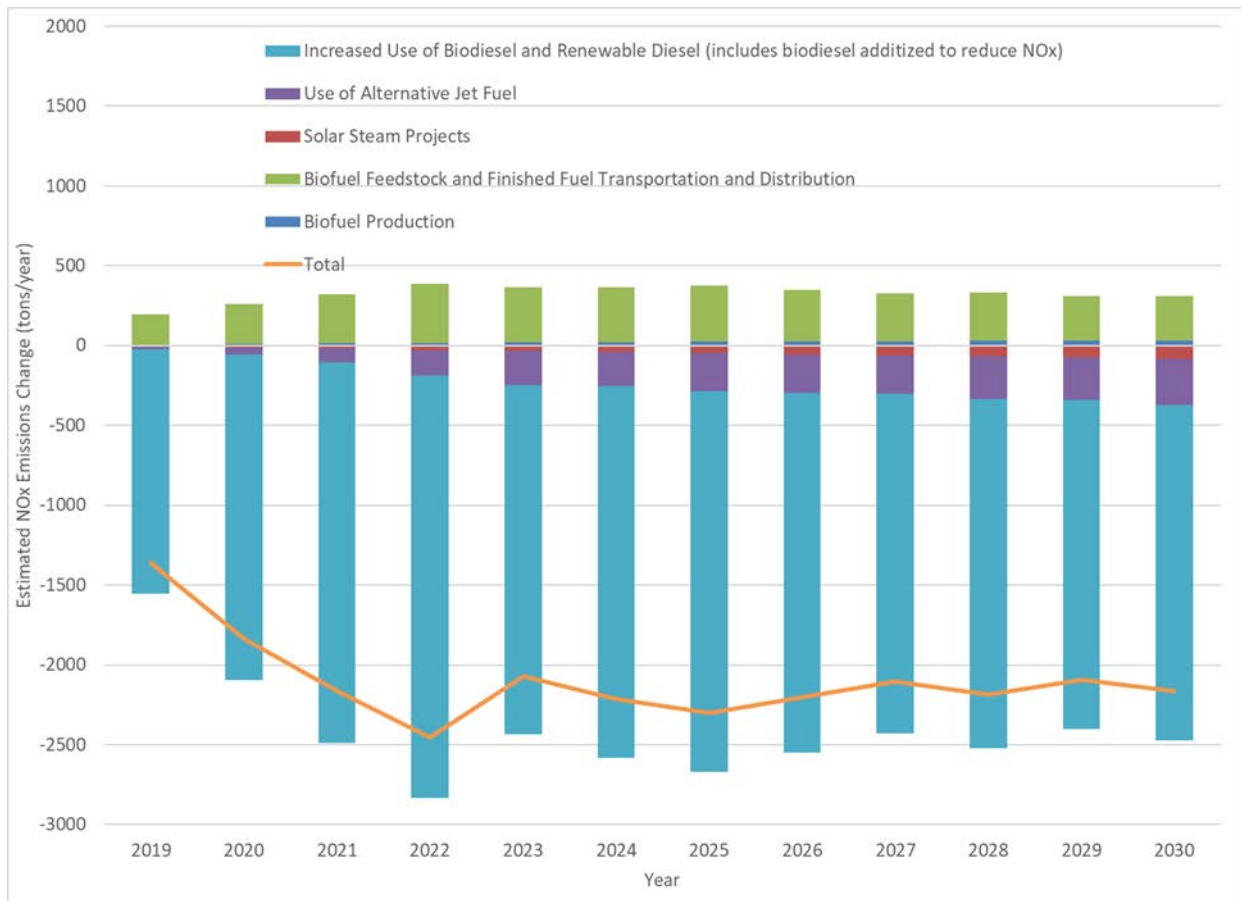
### A. Overview of the Air Quality Analysis and Major Findings

The analysis of the potential air quality impacts of the proposed LCFS amendments was conducted in a manner similar to the analysis of the GHG benefits of alternative fuels

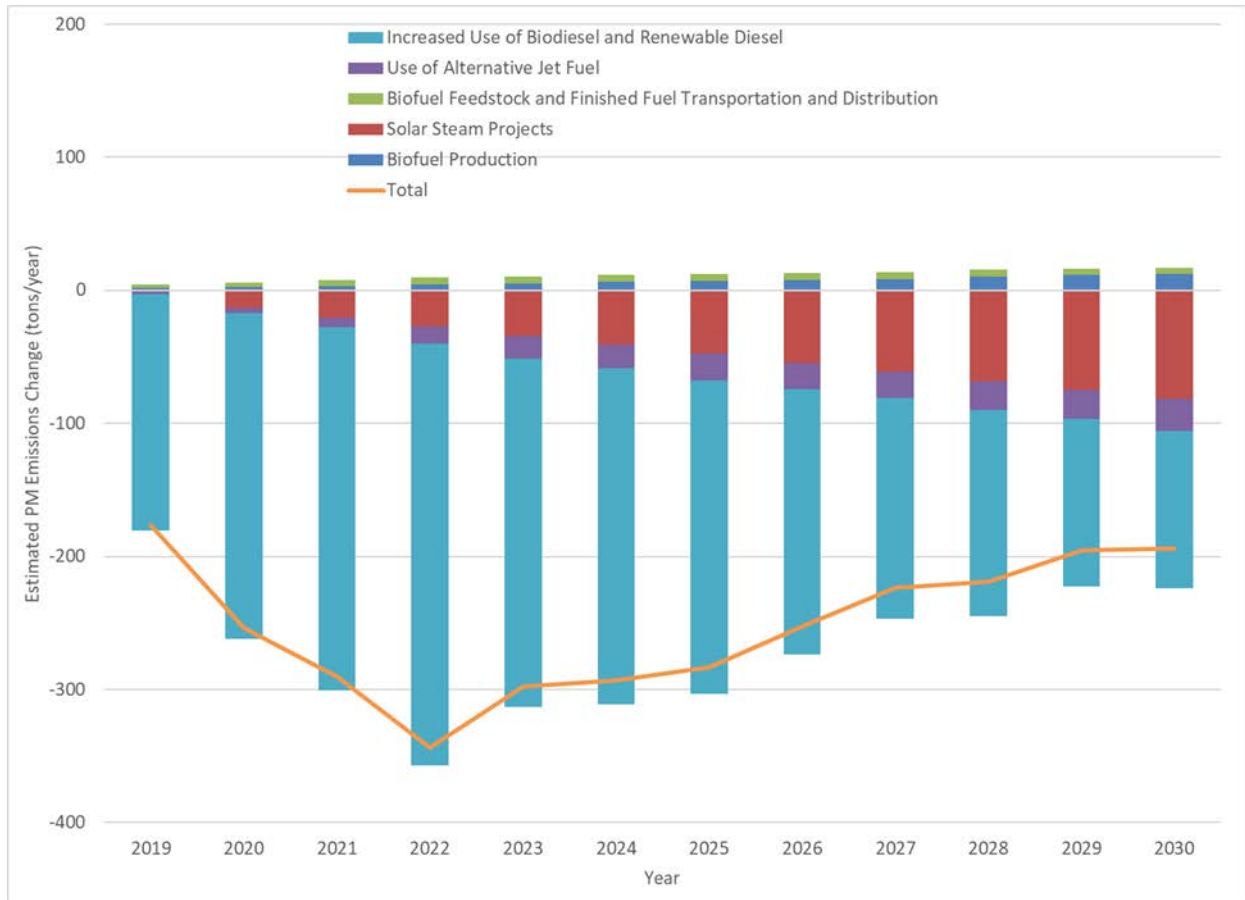
and petroleum-based projects presented in chapter IV. This analysis examines potential changes in air emissions in California from: the transportation of feedstocks to the biofuel production facility; the production of biofuels; the transportation of biofuels to the blending terminal; and finally the combustion of biofuels in vehicles or aircraft. Also analyzed were the effects on emissions of petroleum-based projects such as the implementation of solar steam projects for crude oil production.

The proposed amendments are expected to result in improvements to California’s air quality. The net NOx and PM<sub>2.5</sub> emissions impact of the proposed amendments relative to a 2016 baseline are presented in Figures V-1 and V-2, respectively. As shown, the total NOx and PM<sub>2.5</sub> emissions are estimated to be lower in each year from 2019 through 2030. The annual NOx and PM<sub>2.5</sub> emission reductions represent less than one percent of total statewide emissions.

**Figure V-1: Estimated Statewide NOx Emissions Impact of the Proposed LCFS Amendments Relative to 2016 Baseline (tons/year)**



**Figure V-2: Estimated Statewide PM<sub>2.5</sub> Emissions Impact of the Proposed LCFS Amendments Relative to 2016 Baseline (tons/year)**



As shown in Figure V-2, the estimated PM<sub>2.5</sub> benefits associated with the increased use of biodiesel and renewable diesel initially increase, peaking in year 2022, and then decrease through 2030. This trend results from the competing impacts of an increase in the use of biodiesel and renewable diesel (which both reduce PM<sub>2.5</sub> emissions relative to conventional diesel) coupled with an expected increase in the use of diesel particulate filters (which reduce the benefits of biodiesel and renewable diesel as compared to conventional diesel).

As discussed in section E of this chapter, improvements in California air quality under the proposed amendments are anticipated to result in statewide health benefits for California individuals, including avoided premature deaths, hospitalizations, and emergency room visits. However, due to the complexity of possible LCFS compliance responses, staff cannot fully rule out the possibility of localized impacts due to LCFS-related activities under worst-case assumptions.

## B. Baseline Condition

In order to determine the effects of the proposed LCFS amendments on California air quality, it is first necessary to establish the baseline conditions that currently exist from the production and use of transportation fuels in California. This section describes the existing conditions in response to the current LCFS regulation. The year 2016 was chosen as the “current conditions” baseline for the proposed amendments as 2016 provides the latest complete year of data prior to initiating the air quality assessment.

### 1. 2016 Fossil and Alternative Fuel Volumes

Table V-1 presents the 2016 baseline transportation fuel volumes, which includes both fossil and alternative fuels. Also shown are the quantity of credits generated by petroleum-based projects incented by the LCFS.

**Table V-1: 2016 Baseline of Fossil and Alternative Fuel Quantities and Petroleum-Based Project Credits**

Fuel	Units	Volume
CARBOB	mm gal	13,967
CARB Diesel	mm gal	3,421
Starch Ethanol	mm gal	1,565
Sugar Ethanol	mm gal	32
Electricity for LDVs	MWH	710
Biodiesel	mm gal	163
Renewable Diesel	mm gal	248
Renewable Natural Gas	mm DGE	87
Conventional Natural Gas	mm DGE	55
Electricity for Rail/Forklift/etc.	MWH	1,233
Innovative Crude Credits	MMT	0.001
LC/LEU Refinery	MMT	0.15
Refinery Investment Credits	MMT	0
Refinery Renewable Hydrogen Credits	MMT	0

## 2. Existing Major California Fuel Production Facilities

### a. Petroleum Refineries and Crude Oil Production

Fifteen petroleum refineries produce conventional high-carbon transportation fuel in California.<sup>71</sup> Five of those facilities reside in the Bay Area Air Quality Management District (AQMD), seven reside in the South Coast AQMD, and three reside in the San Joaquin Valley Unified Air Pollution Control District (APCD). A list of the 15 refineries is presented in Table V-2. The list has been updated from the CEC list to reflect the current refinery owners. In total, California refineries process approximately 600 million barrels (25 billion gallons) of crude oil each year, producing gasoline, diesel, and jet fuel for consumption in California and export to surrounding states.

**Table V-2: Currently Operating Petroleum Refineries in California that Produce Transportation Fuel**

Facility Name	Location
Delek US (formerly ALON USA), Bakersfield Refinery	Bakersfield
Chevron U.S.A. Inc.	El Segundo
Chevron U.S.A. Inc.	Richmond
PBF Energy, Inc.	Torrance
Kern Oil & Refining Company	Bakersfield
Paramount Petroleum Corporation	Paramount
Phillips66 Company	Wilmington
Phillips66 Company	Rodeo
San Joaquin Refining Company Inc.	Bakersfield
Shell Oil Products US	Martinez
Andeavor (formerly Tesoro Refining & Marketing Company)	Carson
Andeavor (formerly Tesoro Refining & Marketing Company)	Martinez
Andeavor (formerly Tesoro Refining & Marketing Company)	Wilmington
Valero (Ultramar)	Wilmington
Valero Benicia Refinery	Benicia

Approximately one-third (200 million barrels) of the oil refined in California is produced in the State. This oil is primarily produced in six air districts: Monterey Bay Unified APCD, San Joaquin Valley Unified APCD, San Luis Obispo County APCD, Santa Barbara County APCD, South Coast AQMD, and Ventura County APCD.

CARB compiles each of the local districts' estimates of emissions from stationary sources within its jurisdiction.<sup>72</sup> There are six subcategories that have been used to estimate emissions associated with petroleum refining and crude oil production in each

<sup>71</sup> California's Oil Refineries, California Energy Commission.  
[http://energy.ca.gov/almanac/petroleum\\_data/refineries.html](http://energy.ca.gov/almanac/petroleum_data/refineries.html)

<sup>72</sup> CARB's Emissions Inventory: CEPAM: 2016 SIP - Standard Emission Tool. Available at:  
<https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>

district. These subcategories are: oil and gas production (combustion), petroleum refining (combustion), oil and gas production, petroleum refining, petroleum marketing, and “other” (petroleum production and marketing). Table V-3 shows the estimated emissions from petroleum refining and crude oil production for 2016. The projected emissions are based on the 2012 base year inventory and the growth and control data maintained by the CARB and Districts. The applied control data reflects only adopted rules.

**Table V-3: Estimated 2016 California Petroleum Refining and Crude Oil Production Emissions (tons/year)**

Air District	TOG	ROG	CO	NO <sub>x</sub>	SO <sub>x</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
Bay Area AQMD	27,224	5,877	3,795	4,151	2,579	1,217	1,109	1,071
Santa Barbara County APCD	4,912	1,351	662	622	131	41	41	41
San Joaquin Valley Unified APCD	43,188	6,990	2,239	1,194	272	675	652	648
San Luis Obispo County APCD	442	248	46	163	232	27	26	26
South Coast AQMD	27,444	8,898	3,973	4,299	2,240	1,576	1,219	1,133
Monterey Bay County APCD	2,214	1,103	12	137	11	33	33	33
Ventura County APCD	8,927	917	475	65	13	12	10	9
<b>Total</b>	<b>114,352</b>	<b>25,385</b>	<b>11,202</b>	<b>10,631</b>	<b>5,479</b>	<b>3,580</b>	<b>3,089</b>	<b>2,960</b>

Even though there is expected to be a significant reduction in petroleum-based gasoline and diesel consumption by 2030 in response to fuel economy standards, VMT reduction efforts, and displacement by alternative fuels, staff conservatively assumes, for purposes of calculating air quality benefits of the proposed amendments, that refineries will not operate at a lower capacity in 2030 as compared to 2016.

**b. Ethanol Facilities**

There are currently five permitted ethanol facilities in California, all of which use enzymatic fermentation of starches and sugars. The four largest facilities utilize starch grains as a feedstock while the smallest uses beverage waste. Table V-4 summarizes the location, feedstock, and capacities of these facilities.

**Table V-4: Ethanol Facilities in California**

Facility Name	Location	Feedstock	Capacity (MMgpy)
Aemetis Advanced Fuels	Ceres	sorghum, corn	73.5
Pacific Ethanol	Stockton	corn	64.5
Pacific Ethanol	Madera	corn	43
Pixley Ethanol LLC (Calgren)	Pixley	sorghum, corn	58
Parallel Products	Rancho Cucamonga	beverage waste	4



The following emissions from ethanol facilities in California were obtained from CARB's Emissions Inventory.<sup>73</sup>

**Table V-5: Reported 2015 Emissions from Ethanol Facilities in California (tons/year)**

Facility Name	Air Basin	TOG	ROG	CO	NO <sub>x</sub>	SO <sub>x</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
Aemetis Advanced Fuels	SJV	21.46	16.84	9.62	16.56	3.75	17.96	11.6	8.59
Pacific Ethanol Stockton	SJV	6.13	4.02	11.14	3.05	1.51	8.46	5.31	4.07
Pacific Ethanol Madera	SJV	15.69	12.98	1.03	2.45	0.91	22.94	8.40	2.64
Pixley Ethanol LLC (Calgren)	SJV	2.43	2.21	0.91	0.34	0.02	8.88	2.71	0.24
Parallel Products	SC	2.66	2.13	1.24	1.73	0.03	13.83	9.78	6.01

**c. Biodiesel Facilities**

California biodiesel facilities currently in operation use the fatty-acid methyl ester (FAME) transesterification process to convert waste oils and vegetable oils to biodiesel. There are currently nine operating biodiesel facilities in California. Table V-6 summarizes the location, feedstock source, and estimated capacities for these facilities.

**Table V-6: Biodiesel Facilities in California**

Facility Name	Location	Feedstock	Estimated Capacity (MMgpy)
Imperial Western Products	Coachella	Multi-feedstock	10.5
Community Fuels	Stockton	Multi-feedstock	25.0
Crimson Renewable Energy	Bakersfield	Multi-feedstock	30.0
Simple Fuels Biodiesel Inc.	Chilcoot	Used Cooking Oil	1.0
Western Iowa Energy (formerly Agron Bioenergy LLC)	Watsonville	Multi-feedstock	15.0
GeoGreen Biofuels	Vernon	Used Cooking Oil	3.0
New Leaf Biofuel	San Diego	Used Cooking Oil	6.0
Buster Biofuels LLC	Escondido	Used Cooking Oil	5.0
Biodico Westside	Five Points	Multi-feedstock	18.0

The following emissions from biodiesel facilities in California were obtained from CARB's Emissions Inventory.<sup>74</sup> Emissions data was available for only three of the nine biodiesel facilities.

<sup>73</sup> CARB Facility Search Engine at <https://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php?dd=>

<sup>74</sup> Ibid.

**Table V-7: Reported 2015 Emissions from Biodiesel Facilities in California  
(tons/year)**

Facility Name	Air Basin	TOG	ROG	CO	NO <sub>x</sub>	SO <sub>x</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
Imperial Western Products, Inc.	SC	1.70	1.50	2.19	1.32	0.02	0.20	0.20	0.20
American Biodiesel (Community Fuels)	SJV	6.85	5.17	0.02	0.08	0.03	0.08	0.08	0.08
Crimson Renewable Energy, LP	SJV	13.95	12.01	0.00	0.11	0.16	0.11	0.11	0.11

**d. Renewable Diesel Facilities**

There are currently two renewable diesel facilities in California, both of which use hydrotreating to convert waste oils to renewable diesel. Table V-8 summarizes the location, feedstock, and capacities of these facilities. The renewable diesel production at both Kern Oil and Refining Company and AltAir Paramount, LLC is part of larger petroleum refining operations at both facilities. Therefore, emissions data specific to renewable diesel production at these facilities is not available, but is included in Table V-3.

**Table V-8: Renewable Diesel Facilities in California**

Facility Name	Location	Feedstock	Estimated Capacity (MMgpy)
Kern Oil and Refining Co.	Bakersfield	Tallow	3.45
AltAir Paramount, LLC	Paramount	Multi-feedstock	42

**e. Other Biofuel Facilities**

There is one landfill and one food and green waste digester in California that are providing renewable natural gas for use as transportation fuel. Emissions data are not available for these facilities. There are currently no dairy digesters operating in California to provide transportation fuel.

**f. Estimated Total Emissions from Biofuel Facilities**

Table V-10 shows the estimated total emissions for ethanol, biodiesel, and renewable diesel production in California for 2016. The emissions values in Table V-9 were estimated by multiplying the quantity of fuel produced in 2016 by average emission factors for production of each fuel. These average emission factors were derived from reported data for emissions and fuel production for the year 2015, shown in Tables V-6 and V-8. Since emissions data specific to renewable diesel production is not available, staff used overall petroleum and renewable diesel production data for Kern Oil and Refining Company, which is a simple refinery, as a proxy to estimate an emission factor for renewable diesel production.

**Table V-9: Estimated 2016 Total Emissions for Ethanol, Biodiesel, and Renewable Diesel Production in California (tons/year)**

Fuel	TOG	ROG	CO	NO <sub>x</sub>	SO <sub>x</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
Ethanol	46.60	36.78	23.07	23.52	5.98	69.46	36.43	20.77
Biodiesel	40.96	34.00	4.03	2.75	0.37	0.71	0.71	0.71
Renewable Diesel*	23.00	12.90	9.21	2.98	0.43	0.70	0.68	0.68

\* Using Kern Oil and Refining Company (simple refinery) as a proxy for renewable diesel emissions

### 3. Mobile Sources

Table V-10 below shows 2016 emissions estimates for both on-road and other mobile sources from CARB's emissions inventory.<sup>75</sup> On-road includes emissions from all on-road vehicle classes (i.e. light duty, medium duty, heavy duty, motorcycle, buses, and motorhomes). Other includes emissions from aircraft, trains, ocean going vessels, commercial harbor craft, recreational boats, off-road equipment, and farm equipment. Mobile source emissions are expected to decrease substantially from 2016 through 2030 as a result of non-LCFS factors such as improvements in vehicle fuel economy, turnover to more advanced, lower emission engines, and installation of particulate filters.

**Table V-10: Estimated 2016 Emissions for Mobile Sources in California (tons/year)**

Mobile Source	TOG	ROG	CO	NO <sub>x</sub>	SO <sub>x</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
On-road	119,515	107,726	834,662	256,015	1,812	23,707	23,260	11,021
Other	106,697	94,749	698,682	155,644	2,839	12,071	11,622	10,325
<b>Total</b>	<b>226,211</b>	<b>202,476</b>	<b>1,533,344</b>	<b>411,659</b>	<b>4,650</b>	<b>35,778</b>	<b>34,882</b>	<b>21,347</b>

### 4. Total Transportation Emissions in 2016

Table V-11 below shows the total estimated emissions from transportation-related activities in California in the baseline year of 2016. This table includes emissions from crude oil production, petroleum refining, biofuel production, and mobile sources.

**Table V-11: Estimated Total 2016 Emissions for Transportation (tons/year)**

Emission Source	TOG	ROG	CO	NO <sub>x</sub>	SO <sub>x</sub>	PM	PM <sub>10</sub>	PM <sub>2.5</sub>
Refining and Crude Production	114,352	25,385	11,202	10,631	5,479	3,580	3,089	2,960
Biofuel Production	111	84	36	29	7	71	38	22
Mobile Sources	226,211	202,476	1,533,344	411,659	4,650	35,778	34,882	21,347
<b>Total</b>	<b>340,674</b>	<b>227,945</b>	<b>1,544,582</b>	<b>422,319</b>	<b>10,136</b>	<b>39,429</b>	<b>38,009</b>	<b>24,329</b>

<sup>75</sup> CARB's Emissions Inventory: CEPAM: 2016 SIP - Standard Emission Tool at <https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>.

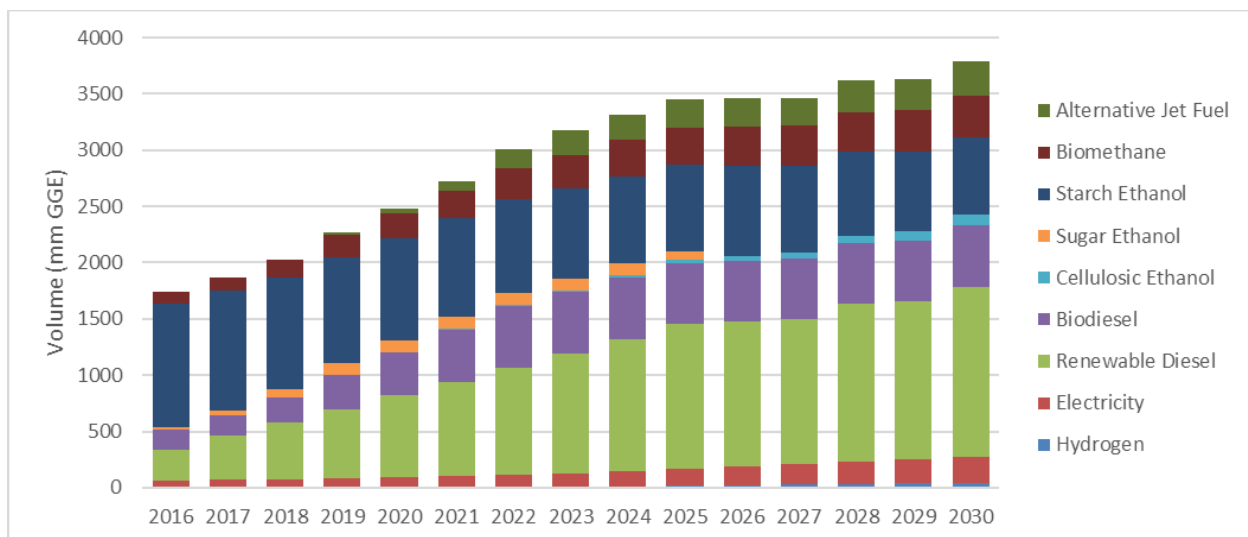
## C. Illustrative Compliance Scenario

As discussed in the economic analysis (see Chapter VIII) for the proposed amendments, staff conducted an in-depth scenario analysis that informed possible compliance schedules through 2030. Staff developed modeling tools that take into account feedstock supply, fuel prices, fuel incentives, and capacity constraints to assess the technical and economic feasibility of bringing low carbon fuels to California. Staff used these modeling tools, together with input from stakeholders and supply projections from subscription services such as Bloomberg New Energy Finance and Lux Research, to assess fuel supply variability and sensitivity to LCFS credit price and other uncertain market effects on a year-by-year basis. The following subsections discuss these changes, with a focus on the major changes from the baseline condition. Additional detail on the scenario analysis is provided in Appendix E.

### 1. Increases in Alternative Fuel Volumes

Figure V-3 illustrates plausible quantities of alternative fuels through 2030 based on the scenario analysis described above. As the proposed amendments retain the market flexibility of the current LCFS, it is not possible to predict the exact path or fuels used for future compliance. Therefore, the projected fuel volumes and associated emission calculations in this chapter should be considered as illustrative only.

**Figure V-3: Illustrative Fuel Volumes that Can Meet the Proposed Amendments (Proposed Amendments Scenario)**



As shown in the figure, the proposed amendments could lead to an increase in consumption of renewable diesel, biodiesel, and alternative jet fuel. The proposed LCFS amendments could also lead to an increase in consumption of cellulosic ethanol from both bolt-on cellulosic processing units at conventional ethanol facilities and stand-alone processing plants.

An increase in electricity, hydrogen, natural gas, and propane use for transportation is also expected to take place. Increased use of these fuels is primarily dependent upon adoption rates for alternative-fueled vehicles, and therefore, despite the value created for these fuels by the LCFS, staff assigns the air quality benefits of these increases to the ZEV regulation and other vehicle incentive programs and not to the LCFS amendments.

## **2. Changes in Sources for Alternative Fuels**

In addition to a potential increase in fuel volumes for alternative fuels, the proposed LCFS amendments could also lead to a change in feedstock sources for some fuels. For example, while the total natural gas vehicle growth is not attributed to the LCFS, the LCFS is assumed to drive the use of renewable natural gas instead of fossil natural gas, particularly the use of lowest-CI renewable natural gas, such as dairy gas.

## **3. Reduction in CI value for Alternative Fuels**

The proposed LCFS amendments could also result in adoption of technologies and process improvements leading to a reduction in CI value for alternative fuels. Staff expects that the proposed amendments could provide sufficient incentive for implementation of carbon capture and sequestration (CCS) at alternative fuel production facilities. For example, capturing CO<sub>2</sub> emissions during ethanol production could further reduce the CI value of starch ethanol and generate additional credits from the same volume of starch ethanol used.

## **4. Project-Based Credits**

The LCFS also includes provisions for crude oil producers or refiners to earn credits based on (1) producing crude oil in an innovative manner, (2) making qualifying, emissions-reducing improvements at refineries, and (3) producing renewable hydrogen at refineries. The proposed LCFS amendments could lead to the development and construction of CCS, solar steam generation, or solar/wind electricity generation projects under the Innovative Crude provision. The proposed LCFS amendments could also lead to the implementation of CCS, electrification of equipment, and replacement of fossil energy by renewable energy sources at refineries under the Refinery Investment and Refinery Renewable Hydrogen credit provisions.

## **D. Changes of Emissions in Response to the Proposed Amendments**

The following air basins in California are not in attainment for the following pollutants:<sup>76</sup>

---

<sup>76</sup> CARB, 2017. Area Designations (Activities and Maps) webpage. Available at: <https://www.arb.ca.gov/desig/changes.htm>. Page reviewed: October 18, 2017.

- Ozone<sup>77</sup>: Great Basin Valleys, Lake Tahoe, Mojave Desert, Mountain Counties, North Central Coast, Sacramento Valley, Salton Sea, San Diego, San Francisco Bay Area, San Joaquin Valley, South Central Coast, South Coast;
- PM<sub>2.5</sub><sup>78</sup>: Mojave Desert, Mountain Counties, Sacramento Valley, Salton Sea, San Diego, San Francisco Bay Area, San Joaquin Valley, South Coast;
- PM<sub>10</sub><sup>79</sup>: Great Basin Valleys, Lake Tahoe, Mojave Desert, Mountain Counties, North Central Coast, North Coast, Northeast Plateau, Sacramento Valley, Salton Sea, San Diego, San Francisco Bay Area, San Joaquin Valley, South Central Coast, South Coast

Because California is in attainment for all criteria pollutants except for ozone, PM<sub>2.5</sub>, and PM<sub>10</sub>, staff focused on NOx, which is a precursor for ozone formation, and PM emissions in the following analysis.

## 1. Changes in Tailpipe Emissions

### a. Increased use of Biodiesel and Renewable Diesel

As shown for the illustrative scenario depicted in Figure V-3, staff expects an increased use of biodiesel and renewable diesel as a result of the proposed LCFS amendments. To determine the impact of this increase on tailpipe emissions, staff analyzed the NOx and PM changes (relative to the 2016 baseline) using the methodology described in the Supplemental Disclosure of Oxides of Nitrogen Potentially Caused by the Low Carbon Fuel Standard, included as Appendix G of this Staff Report. For this analysis staff assumed that the ADF regulation in-use requirements for biodiesel would not sunset in 2023 in the Proposed Amendments Scenario, as the ADF regulation is being amended in conjunction with these LCFS amendments.

As illustrated in Figure V-4, staff found that biodiesel use attributed to the LCFS would result in a potential increase in NOx emissions relative to use of conventional diesel in all years from 2019 through 2030. Even though the consumption of biodiesel in California is expected to increase over time, the NOx emissions impact is expected to decrease as the result of NOx mitigation of higher biodiesel blend levels required by the ADF regulation and the turnover to lower-NOx engines. Staff also found that renewable diesel use attributed to the LCFS would result in a decrease in NOx emissions relative to use of conventional diesel for the same years. Also shown on this figure are the emissions changes for biodiesel and renewable diesel use in the baseline year of 2016. Overall, staff found that biomass-based diesel use attributed to the LCFS would result in

---

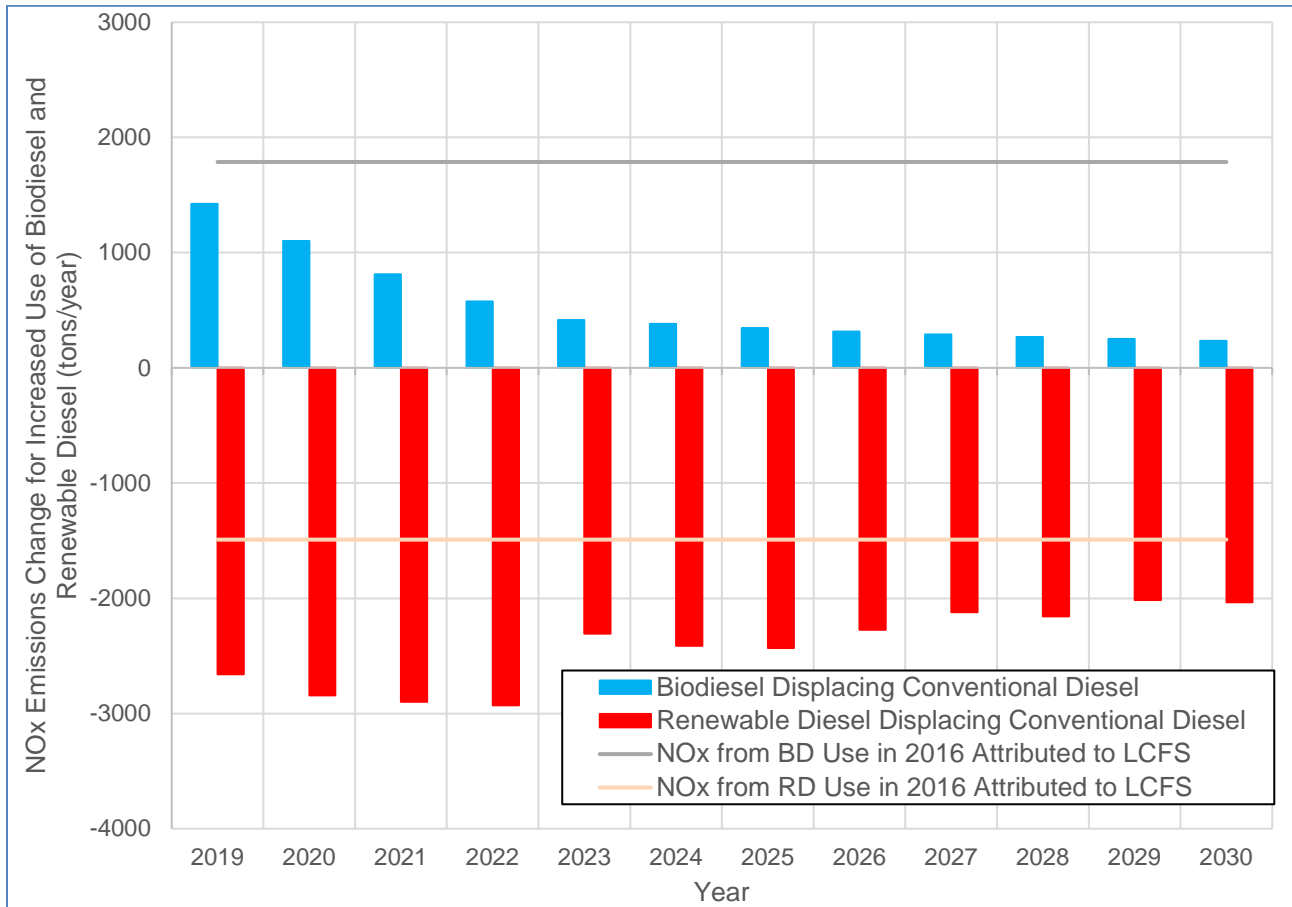
<sup>77</sup> CARB. Source Date June 2017. "Area Designations for State Ambient Air Quality Standards - Ozone." Webpage: [https://www.arb.ca.gov/desig/adm/2016/state\\_o3.pdf](https://www.arb.ca.gov/desig/adm/2016/state_o3.pdf)

<sup>78</sup> CARB. Updated June 7, 2017. "Chronology of State PM2.5 Designations." Webpage: <https://www.arb.ca.gov/desig/changes/pm25.pdf>.

<sup>79</sup> CARB. Updated June 7, 2017. "Chronology of State PM10 Designations." Webpage: <https://www.arb.ca.gov/desig/changes/pm10.pdf>.

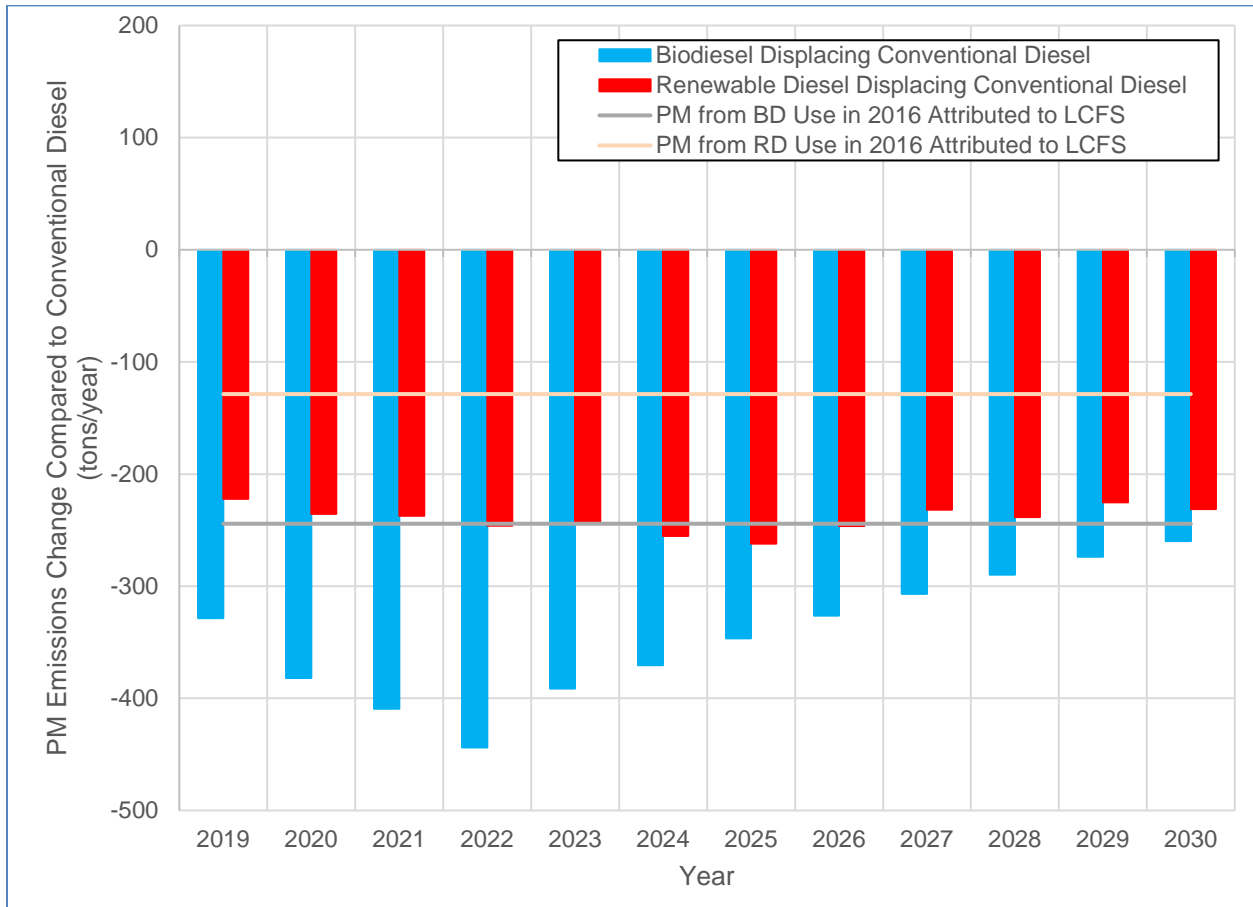
a potential decrease in NOx emissions relative to the 2016 baseline in all years for the scenario evaluated.

**Figure V-4: Estimated Change in NOx Emissions Due to LCFS-Attributed Biodiesel and Renewable Diesel Use**



Staff also found that biodiesel and renewable diesel use attributed to the LCFS could result in a decrease in PM emissions relative to use of conventional diesel from 2019 through 2030. This is illustrated in Figure V-5. Also shown in the figure are the emissions changes attributable to biodiesel and renewable diesel use in the baseline year of 2016. Overall, staff found that biomass-based diesel use attributed to the LCFS could result in PM emissions decrease relative to the 2016 baseline in all years for the scenario evaluated.

**Figure V-5: Estimated Change in PM Emissions Due to LCFS-Attributed Biodiesel and Renewable Diesel Use**



**b. Feedstock and Finished Fuel Transport**

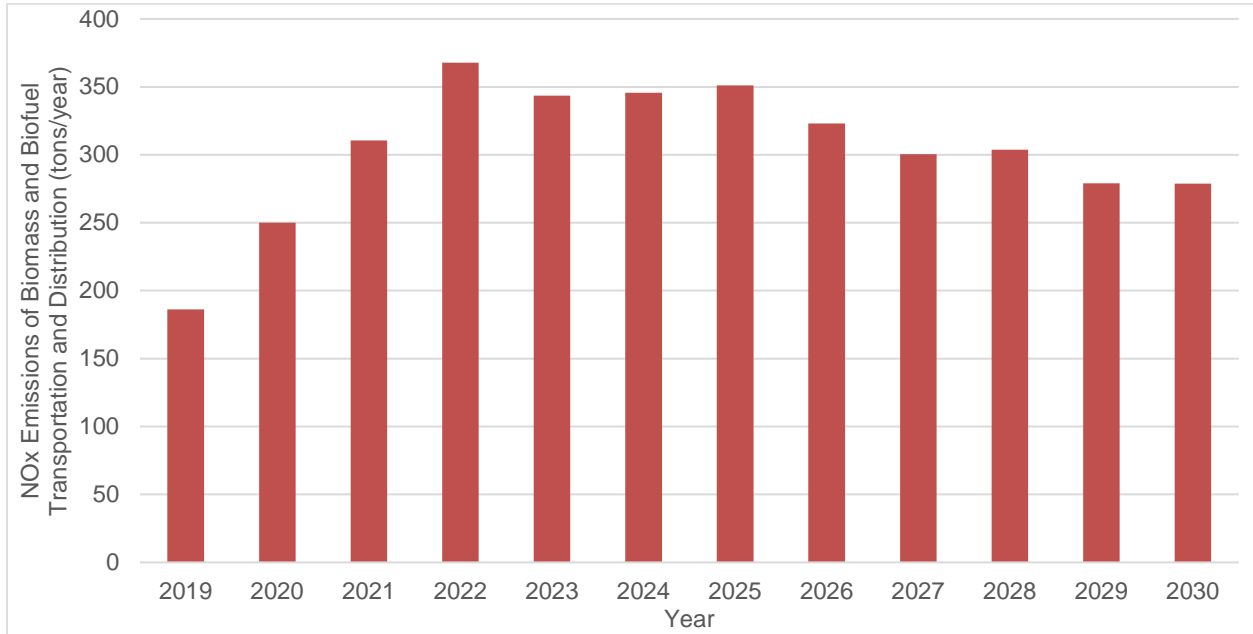
Staff estimated the NOx and PM<sub>2.5</sub> emissions in California resulting from the transportation and distribution of biofuel feedstocks and finished fuels for years 2019 through 2030. Staff expects that the proposed amendments would result in an increase in production of low carbon fuels in California, thereby requiring increased transport of feedstock to biofuel production facilities and increased transport of finished biofuel to blending facilities. An increase in the import of biofuels is also expected to occur as a result of the proposed amendments, requiring an increase in transport of these fuels to rail terminals and blending facilities in California. Detailed calculations used to determine the estimated emissions for feedstock and finished fuel transport can be found in Appendix F.

Emissions of NOx and PM<sub>2.5</sub> due to biomass and biofuel transportation and distribution attributed to LCFS amendment are illustrated in Figures V-6 and V-7, respectively. As shown in both figures, there is a projected increase in both NOx and PM<sub>2.5</sub> emissions due to biomass and biofuel transportation and distribution as a result of the proposed LCFS amendments. However, these emission increases are much less than the

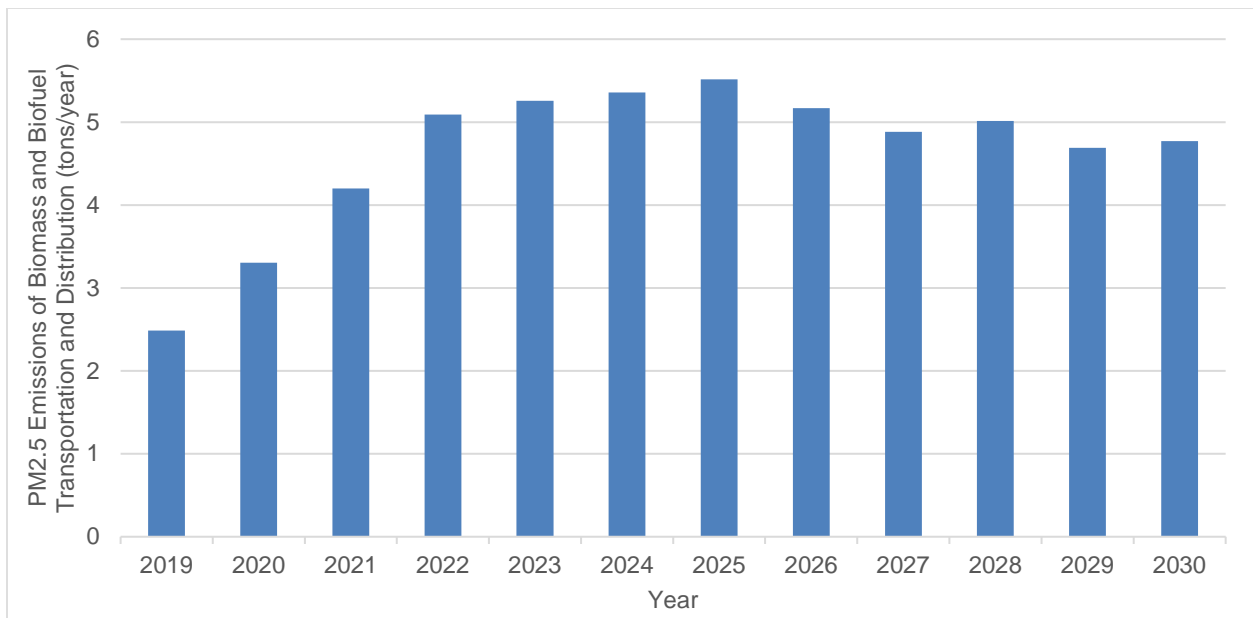


tailpipe emission benefits provided by use of biodiesel and renewable diesel as indicated in Figures V-4 and V-5.

**Figure V-6: Estimated Change in NOx Emissions for Biofuel Feedstock and Finished Fuel Transportation and Distribution Relative to 2016 Baseline**



**Figure V-7: Estimated Change in PM<sub>2.5</sub> Emissions for Biofuel Feedstock and Finished Fuel Transportation and Distribution Relative to 2016 Baseline**

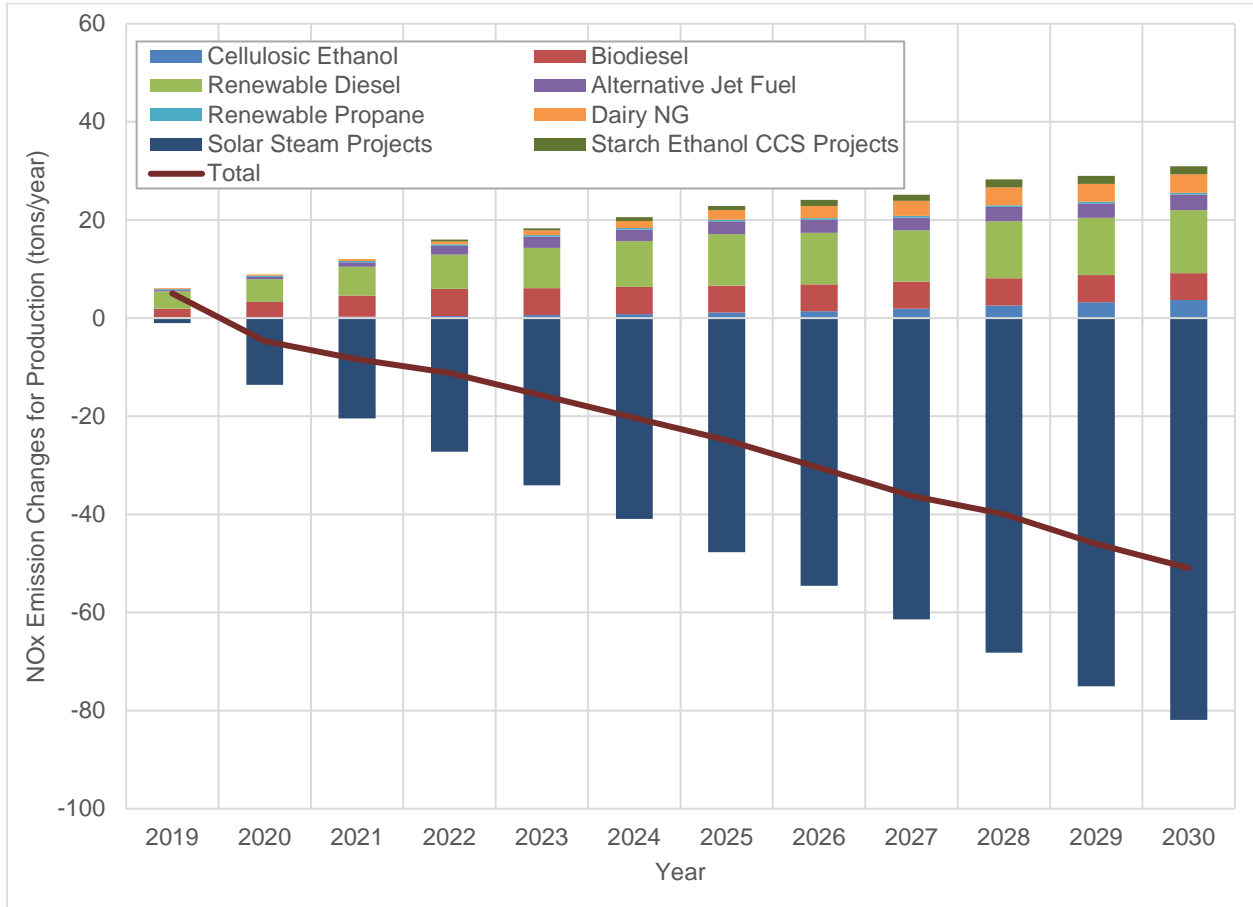


## **2. Changes in Emissions at California Alternative Fuel Facilities and Petroleum-Based Projects**

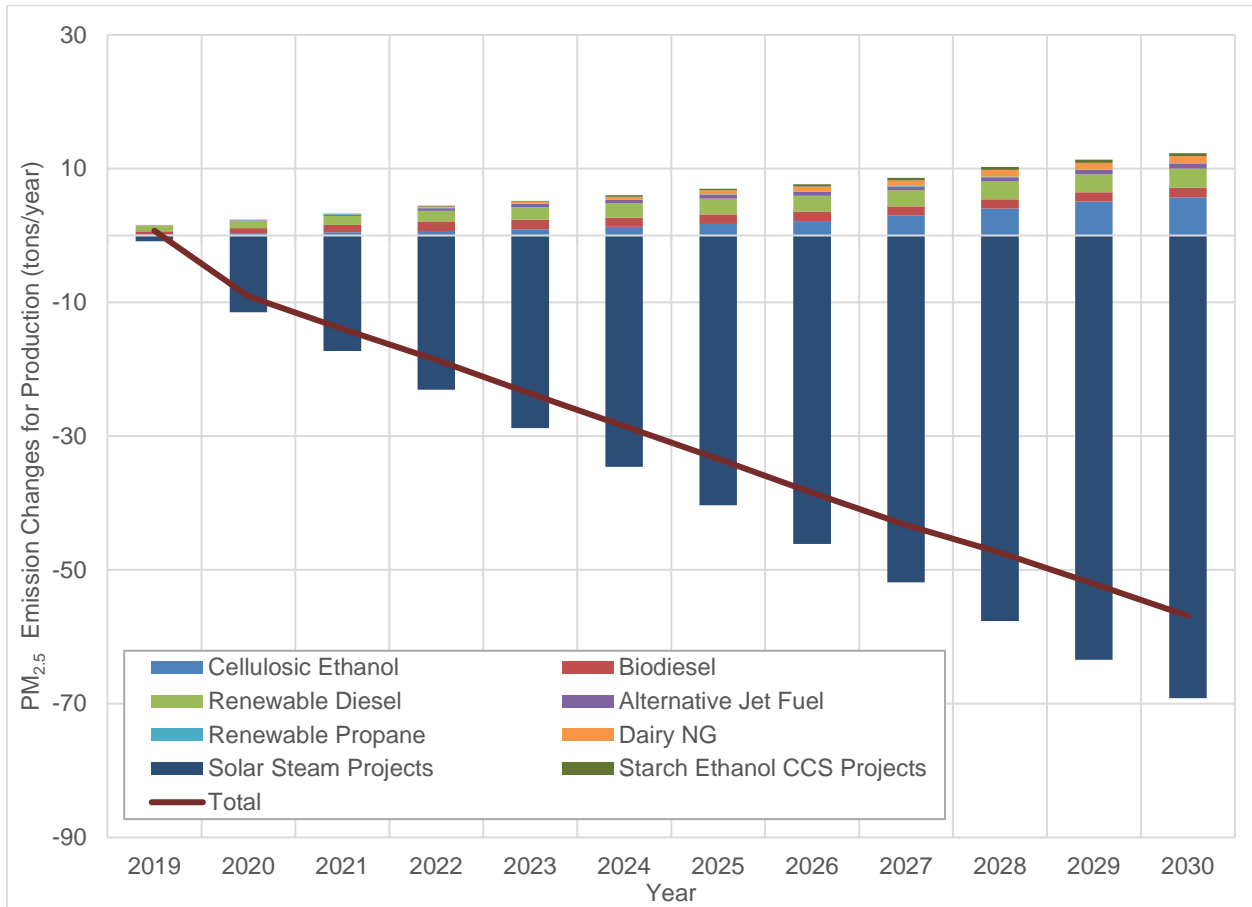
Staff expects the proposed amendments would result in an increase in production and/or expansion at California alternative fuel facilities, which would result in increased NO<sub>x</sub> and PM<sub>2.5</sub> emissions at these facilities. Increases in in-state production are expected to occur for biodiesel, renewable diesel, alternative jet fuel, renewable propane, cellulosic ethanol and dairy digester gas. Although staff does not expect a significant change in in-state production of starch ethanol, CCS may be implemented at ethanol facilities resulting in increased demand for electricity for CO<sub>2</sub> compression. The LCFS also provides opportunities to reduce the carbon intensity in conventional petroleum supply chains. One of these opportunities is to produce crude oil using innovative methods, such as implementation of CCS, solar steam, and renewable electricity projects at oil fields. Staff expects the proposed amendments would further incentivize the use of these innovative methods, and, in particular, solar steam projects in San Joaquin Valley may potentially be a significant source of LCFS credits through 2030. Detailed calculations for changes in emissions at alternative fuel production facilities and for solar steam generation can be found in Appendix F.

Estimated changes in NO<sub>x</sub> and PM<sub>2.5</sub> emissions for years 2019 through 2030 for alternative fuel production facilities and solar steam projects are shown in Figures V-8 and V-9, respectively. As shown in both figures, there is a projected net decrease in both NO<sub>x</sub> and PM<sub>2.5</sub> emissions on a statewide basis due to the large reduction in emissions from natural gas-fired steam generators as solar steam projects are implemented. The emission reductions from implementation of solar steam at oil fields are expected to primarily occur in the San Joaquin Valley air basin. Other air basins are expected to experience small net increases in emissions from alternative fuel production. Staff assumed that future increases in biofuel production would likely occur in the same air basins where current biofuel production is occurring; including South Coast, San Francisco Bay, San Joaquin Valley, San Diego, and Salton Sea.

**Figure V-8: Estimated Change in NOx Emissions from Alternative Fuel Production Facilities and Petroleum-Based Projects Relative to 2016 Baseline**



**Figure V-9: Estimated Change in PM<sub>2.5</sub> Emissions from Alternative Fuel Production Facilities and Petroleum-Based Projects Relative to 2016 Baseline**



### 3. Changes in Aviation Emissions from Use of Alternative Jet Fuel

Staff expects that the proposed amendments would increase the use of AJF at California airports resulting in changes in emissions during taxi, takeoff, and landing operations. Recent studies have shown that there are significant reductions in particulate matter and sulfur oxide emissions<sup>80,81,82</sup> and a slight reduction or no change

<sup>80</sup> Boeing Company, UOP, U.S. Air Force Research Laboratory, 2011. Evaluation of Bio-Derived Synthetic Paraffinic Kerosenes (Bio2SPK), Committee D02 on Petroleum Products and Lubricants, Subcommittee D02.J0.06 on Emerging Turbine Fuels, Research Report D02-1739, ASTM International, West Conshohocken, PA, 28 June 2011.

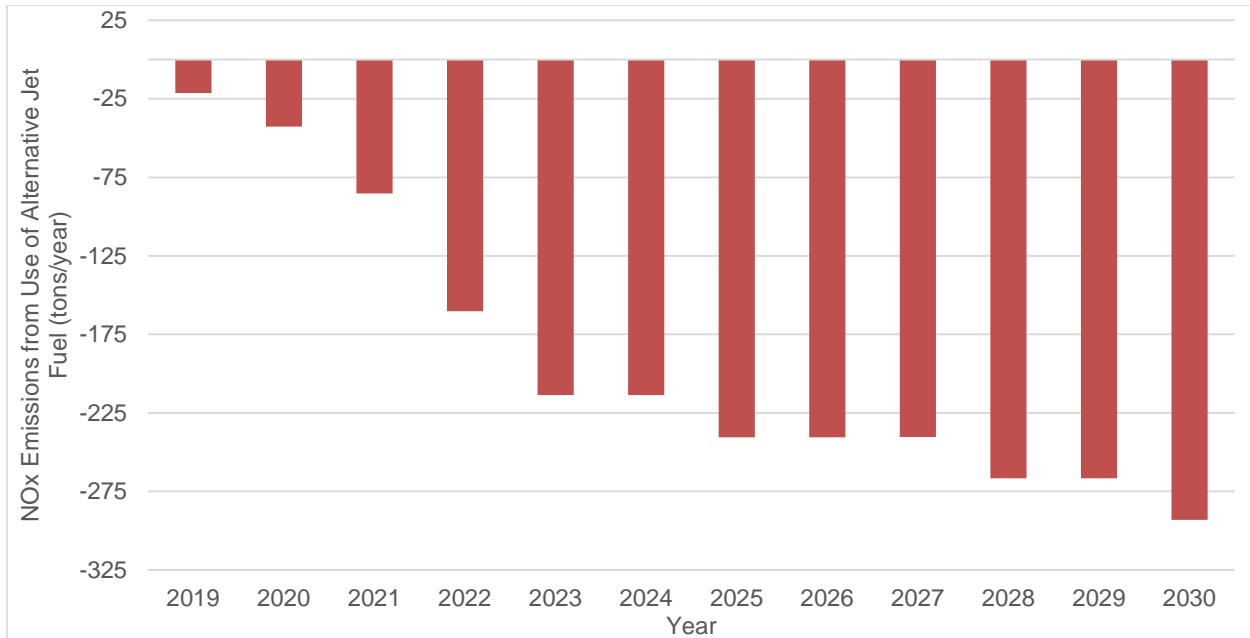
<sup>81</sup> Roland, O. and Garcia, F., 2014. TOTAL New Energies, Amyris, Inc., U.S. Air Force Research Laboratory, Evaluation of Synthesized Iso-Paraffins Produced from Hydroprocessed Fermented Sugars (SIP Fuels), Final Version (3.), Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants, Subcommittee D02.J0 on Aviation Fuels, Research Report D02-1776, ASTM International, West Conshohocken, PA, 15 June 2014.

<sup>82</sup> Edwards, T., Meyer, D., Johnston, G., McCall, M., Rumizen, M., and Wright, M., 2016. Evaluation of Alcohol to Jet Synthetic Paraffinic Kerosenes (ATK2SPK), Report Version (1.10), Committee D02 on

in nitrogen oxides (NO<sub>x</sub>)<sup>83,84,85</sup> emissions when AJFs replace conventional jet fuel. A detailed discussion of the methodology used to determine the estimated changes in aviation emissions from the use of AJF can be found in Appendix F.

Estimated changes in emissions of NO<sub>x</sub> and PM<sub>2.5</sub> from use of AJF are illustrated in Figures V-10 and V-11, respectively.

**Figure V-10: Estimated Change in NO<sub>x</sub> Emissions from Use of Alternative Jet Fuel Relative to 2016 Baseline**



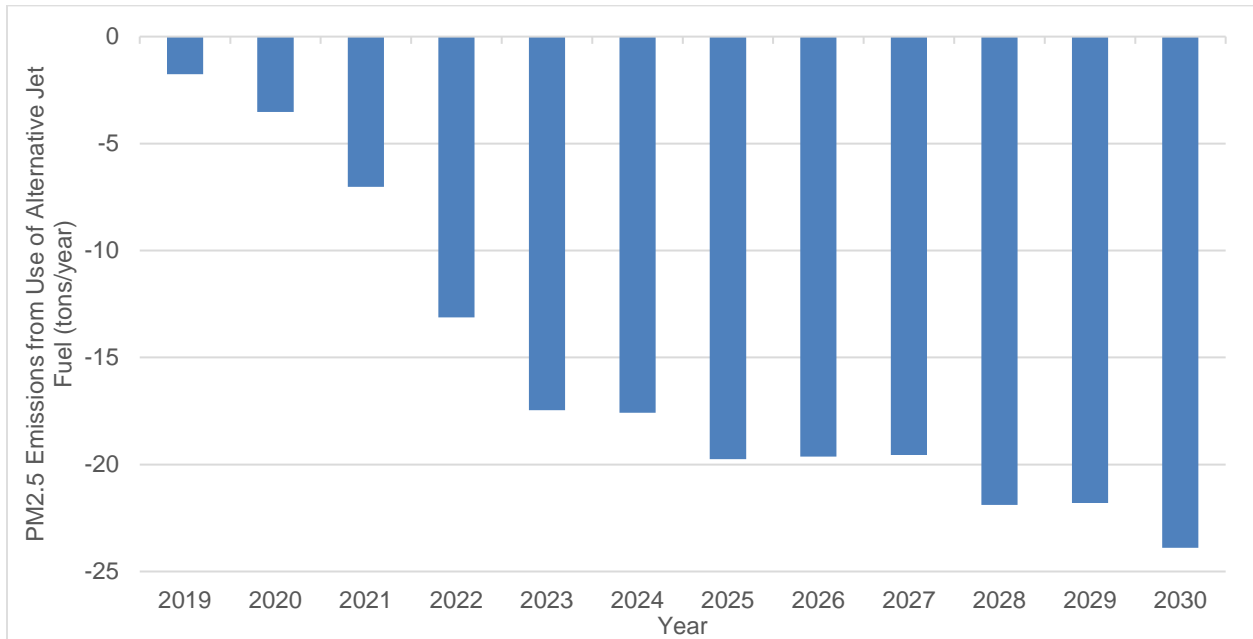
Petroleum Products, Liquid Fuels, and Lubricants, Subcommittee D02.J0 on Aviation Fuels, Research Report D02-1828, ASTM International, West Conshohocken, PA, 1 April 2016.

<sup>83</sup> Corporan, E., DeWitt, M.J., Klingshirn, C.D., Anneken, D., 2010. Alternative Fuels Tests on a C-17 Aircraft: Emissions Characteristics, Air Force Research Laboratory, Interim Report, AFRL-RZ-WP-TR-2011-2004, Wright-Patterson Air Force Base, OH, December 2010.

<sup>84</sup> Carter, Nicholas A., Stratton, R.W., Bredehoeft, M.K., and Hileman, 2011. J.I. Energy and Environmental Viability of Select Alternative Jet Fuel Pathways, 47th AIAA/ASME, SAE, ASEE Joint Propulsion Conference & Exhibit, San Diego, CA, AIAA 2011-15968, 31 July – 03 August 2011.

<sup>85</sup> Lobo et al., 2012. Impact of Alternative Fuels on Emissions Characteristics of a Gas Turbine Engine – Part 1: Gaseous and Particulate Matter Emissions. Environmental Science & Technology 2012 46 (19), 10805-10811. DOI: 10.1021/es301898u

**Figure V-11: Estimated Change in PM<sub>2.5</sub> Emissions from Use of Alternative Jet Fuel Relative to 2016 Baseline**



**5. Qualitative Summary of Changes in Other Emissions and Tools to Deal with Local Impacts**

As discussed previously, the proposed amendments could result in the increased production of ethanol, biodiesel, renewable diesel and biomethane in California, as well as the use of CCS at biofuel and fossil fuel refineries. Viewed in isolation, some of these activities may raise concerns about increases in emissions of air pollutants associated with feedstock transport to production facilities, production of biofuels, and transport of finished fuels to blending facilities. Staff has shown quantitatively the cumulative impact of the two criteria pollutants of most concern statewide (NO<sub>x</sub> and PM<sub>2.5</sub>) are likely reduced by the proposed amendments.

However, these are not the only pollutants of concern at the local level and, even with respect to NO<sub>x</sub> and PM<sub>2.5</sub>, small emission increases may occur at a localized level near feedstock and finished fuel transportation routes and near production facilities. Other air emissions may be of greater concern at the local level. Since not all impacts can be quantified and some qualitative benefits could be significant, staff provides a qualitative summary of these impacts in this section before turning to health benefits of the quantitative analysis both statewide and for an example bio refinery.

CARB and the State generally are prepared to address any local emission issues using a variety of policy tools. First, emissions from stationary sources are regulated by air districts to minimize the negative impacts from the increased production. Any new biofuel production facilities would be required to follow all State and local emission standards to protect public health and the environment, and could employ the strategies

in CARB's biorefinery siting facility guidance document to reduce possible impacts.<sup>86</sup> CARB continues to drive down emissions from mobile sources, including those that would serve biorefineries. Under State Implementation Plans (SIPs), states are required to provide comprehensive plans to attain the NAAQS set by the U.S. EPA. CARB reviews and approves local area districts and other agencies SIP elements and ensures they achieve the State's criteria pollution targets.

Additionally, AB 617 directs CARB to cooperate with local air districts to implement criteria pollutant reduction programs in high exposure communities. AB 617 requires CARB to establish and maintain a database of the best-available retrofit control technology for criteria pollutants. The programs, standards, and plans specified under the SIPs and AB 617 will ensure that any increase in emissions from increased activity due to the proposed amendments will be controlled to minimize the impacts on California residents, especially in areas with poor air quality.

CCS projects have the potential to contribute to additional criteria pollutant and air toxics emissions from activities related with CO<sub>2</sub> capture, compression, transport, and injection. The amount and scale of potential air pollutant emissions from CCS projects can vary widely, from reductions in emissions to large emissions increases based on the industrial process from which CO<sub>2</sub> is captured and the technology used to capture the CO<sub>2</sub>. Since CCS generally requires substantial amounts of energy use, additional air pollutant emissions are expected from the implementation of most types of CCS projects. A study by the European Environmental Agency has shown that increases in criteria and air toxics emissions are well correlated with the magnitude of the energy demands of the CCS process.<sup>87</sup> Carbon capture tends to be by far the most energy intensive and expensive step in a CCS project. CCS projects involving processes that produce low purity CO<sub>2</sub> would require far greater energy demand than CCS projects involving high purity CO<sub>2</sub>.<sup>88</sup> Accordingly, the greater the CCS project's CO<sub>2</sub> purity, the lower the expected increases in criteria and air toxics emissions. In the near term, most potential CCS projects would likely occur in processes that already produce high purity CO<sub>2</sub> streams, such as ethanol production and certain forms of steam methane reforming. These projects do not require a CO<sub>2</sub> capture step and are expected to occur sooner due to their lower cost. Therefore, these near term projects are likely to incur minimal changes in criteria and toxics emissions as a result of CO<sub>2</sub> compression, transport, and injection. For CCS projects that produce low purity CO<sub>2</sub> streams such as power plants, the CO<sub>2</sub> capture technology would likely be primarily based on chemical adsorption using amine-based solvents such as monoethanolamine (MEA).<sup>89</sup> Because

---

<sup>86</sup> See <https://www.arb.ca.gov/fuels/lcfs/bioguidance/biodocs/finalbiorefineryguidenov2011.pdf>. Adopted in November 2011.

<sup>87</sup> European Environmental Agency. "Air pollution impacts from carbon capture and storage (CCS)." EEA Technical report No 14/2011 (2011).

<sup>88</sup> High purity CO<sub>2</sub> is CO<sub>2</sub> that only requires dehydration, ~98%. Low purity can be anywhere from as low as ~400ppm (atmospheric CO<sub>2</sub>) to ~15% (industrial processes and coal power production)

<sup>89</sup> Capture technologies such as pre-combustion capture, other solvents or sorbents, or entirely new power cycles, may have different emissions impacts but have not yet been demonstrated commercially.

amine-based solvents used in carbon capture systems would be recycled in a closed system, emissions of amine-based solvents associated with carbon capture systems would be minimal.

The potential substitution from fossil fuels to electricity, hydrogen, natural gas and liquid biofuels could result in decreases in other criteria pollutants and toxics associated with gasoline tailpipe emissions and refueling infrastructure. Fossil fuels contain BTEX compounds, benzene, toluene, ethyl benzene, and xylenes, which can be emitted to the air and also contaminate soil and water. Gasoline-engine exhaust contains benzene, 1,3-butadiene, formaldehyde, and acetaldehyde. Diesel-engine exhaust contains not only diesel particulate matter, which is a TAC, but also poly-nuclear (polycyclic) aromatic hydrocarbons (PAHs). Generally, all exhaust from the combustion of hydrocarbon fuels contains benzene as a product of incomplete combustion (PIC). Staff expects a decrease in use of fossil fuels to result in decreases in these criteria pollutants and toxics in regions with heavy use of motor vehicles and diesel engines, such as big population centers (e.g., South Coast) and areas with heavy truck use (San Joaquin Valley).

The substitution from fossil jet fuel to alternative jet fuel might also contribute to a decrease in the emission of other criteria pollutants and toxics, especially around airports with heavy air traffic. Alternative jet fuels derived from hydrotreating of vegetable oils and animal fats do not contain aromatic compounds (benzene, naphthalene, and methylnaphthalene),<sup>90</sup> and emit less sulfur oxides (SOx) when compared to fossil jet fuel. However, it is unclear whether alternative jet fuels emit less or more CO or unburned hydrocarbons than fossil jet fuels<sup>91,92</sup>. The U.S. EPA National Ambient Air Quality Standards (NAAQS) include standards for CO, and California is in attainment for all air basins. Given California is in attainment and the small volumes of alternative jet fuel anticipated to be used as a result of the proposed amendments, any impacts on CO emissions are expected to be negligible.

## **E. Health Impacts Analysis**

Improvements in California air quality under the proposed amendments are anticipated to result in health benefits for California individuals. The proposed amendments will

---

<sup>90</sup> Boeing Company, UOP, U.S. Air Force Research Laboratory, 2011. Evaluation of Bio-Derived Synthetic Paraffinic Kerosenes (Bio2SPK), Committee D02 on Petroleum Products and Lubricants, Subcommittee D02.J0.06 on Emerging Turbine Fuels, Research Report D02-1739, ASTM International, West Conshohocken, PA, 28 June 2011.

<sup>91</sup> Edwards, Tim, Meyer, D., Johnston, G., McCall, M., Rumizen, M., Wright, M., "Evaluation of Alcohol to Jet Synthetic Paraffinic Kerosenes (ATJ-SPKs)," Report Version (1.10), Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants, Subcommittee D02.J0 on Aviation Fuels, Research Report D02 1828, ASTM International, West Conshohocken, PA, 1 April 2016.

<sup>92</sup> Corporan, Edwin, Edwards, T., Shafer, L., DeWitt, M.J., Klingshirn, C.D., Zabarnick, S., West, Z., Striebich, R., Graham, J., Klein, J. Chemical, Thermal Stability, Seal Swell, and Emissions Studies of Alternative Jet Fuels. *Energy & Fuels*, 25, 955-966, 2011.



affect air quality through three main categories of emissions: 1) tailpipe emissions reductions for on-road and off-road vehicles, 2) aircraft emissions reductions at and near airports, and 3) changes in emissions at stationary sources from alternative fuel production and steam production at oil fields.<sup>93,94</sup>

CARB analyzed changes in five health outcomes: cardiopulmonary<sup>95</sup> mortality, hospitalizations for cardiovascular<sup>96</sup> illness, hospitalizations for respiratory<sup>97</sup> illness, emergency room (ER) visits for respiratory illness, and ER visits for asthma.

Staff selected these health outcomes because U.S. EPA has identified these as having a *causal* or *likely causal* relationship with exposure to PM<sub>2.5</sub>.<sup>98</sup> The U.S. EPA examined other health endpoints such as cancer, reproductive and developmental effects, but determined there was only *suggestive* evidence for a relationship between these outcomes and PM exposure, and insufficient data to include these endpoints in the national health assessment analyses routinely performed by U.S. EPA.

The U.S. EPA has determined that both long-term and short-term exposure to PM<sub>2.5</sub> plays a *causal* role in premature mortality, meaning that a substantial body of scientific evidence shows a relationship between PM<sub>2.5</sub> exposure and increased risk of death. This relationship persists when other risk factors such as smoking rates, poverty and other factors are taken into account.<sup>99</sup> While other mortality endpoints could be

---

<sup>93</sup> Emissions from alternative fuel production facilities and other stationary sources were multiplied by 0.2 to account for the difference in the way those emissions affect exposed populations compared to on-road vehicle emissions. Emissions from production facilities, which are released from tall stacks relatively distant from residential areas, are expected to result in lower impacts than emissions from motor vehicles at ground level, on roadways that run through residential neighborhoods. The factor of 0.2 was derived by comparing the intake fraction (IF) of the two sources. IF is the fraction of total emissions of air pollutant that is inhaled by a receptor population during a certain time period, and is estimated by combining air pollutant concentration enhancement and population distribution near the source. The current study estimates IF of PM<sub>2.5</sub> from three major refineries located in Los Angeles County using the U.S. EPA approved AERMOD model. The IF for refineries is then compared against published estimates of the IF of on-road diesel vehicles in the South Coast Air Basin to obtain the ratio of 20 percent.

<sup>94</sup> Marshall, J.D., Teoh, S., and Nazaroff, W. 2003. Intake fraction of primary pollutants: motor vehicle emissions in the South Coast Air Basin. *Atmospheric Environment* 37 (2003) 3455–3468. Available at: <http://uctc.berkeley.edu/research/papers/772.pdf>.

<sup>95</sup> Outcomes related to the heart or lungs

<sup>96</sup> Outcomes related to the heart or blood vessels

<sup>97</sup> Respiratory illness such as chronic obstructive pulmonary disease, and respiratory infection

<sup>98</sup> U.S. EPA, 2010. Quantitative Health Risk Assessment for Particulate Matter (Final Report). [https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM\\_RA\\_FINAL\\_June\\_2010.pdf](https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf).

<sup>99</sup> U.S. EPA, 2009. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F. [http://ofmpub.epa.gov/eims/eimscomm.getfile?p\\_download\\_id=494959](http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959).

analyzed, the strongest evidence exists for cardiopulmonary mortality.<sup>100</sup> The greater scientific certainty for this effect, along with the greater specificity of the endpoint, leads to an effect estimate for cardiopulmonary deaths that is both higher and more precise than that for all-cause mortality.<sup>101</sup>

The U.S. EPA has also determined a *causal* relationship between non-mortality cardiovascular effects and short and long-term exposure to PM<sub>2.5</sub>, and a *likely causal* relationship between non-mortality respiratory effects (including worsening asthma) and short and long-term PM<sub>2.5</sub> exposure.<sup>102</sup> These outcomes lead to hospitalizations and ER visits, and are included in this analysis.

In general, health studies have shown that populations with low socioeconomic standings are more susceptible to health problems from exposure to air pollution.<sup>103,104</sup> However, the models currently used by U.S. EPA and CARB do not have the granularity to account for this impact. The location and magnitude of projected emission reductions resulting from many proposed regulations are not known with sufficient accuracy to account for socioeconomic impacts, and an attempt to do so would produce uncertainty ranges so large as to make conclusions difficult. Staff acknowledges this limitation.<sup>105</sup>

Table V-12 shows the estimated avoided mortality and morbidity incidence as a result of the proposed amendments scenario for 2019 through 2030 by California air basin. Values in parenthesis represent the 95 percent confidence intervals of the central estimate. The proposed amendments scenario is estimated to reduce overall emissions of PM<sub>2.5</sub> and NO<sub>x</sub> in all years, and leads to a net statewide health benefit.

---

<sup>100</sup> U.S. EPA, 2009. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F. [http://ofmpub.epa.gov/eims/eimscomm.getfile?p\\_download\\_id=494959](http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959).

<sup>101</sup> CARB, 2010. Estimate of Premature Deaths Associated with Fine Particle Pollution (PM<sub>2.5</sub>) in California Using a U.S. Environmental Protection Agency Methodology. [https://www.arb.ca.gov/research/health/pm-mort/pm-report\\_2010.pdf](https://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf).

<sup>102</sup> U.S. EPA, 2009. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F. [http://ofmpub.epa.gov/eims/eimscomm.getfile?p\\_download\\_id=494959](http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959).

<sup>103</sup> Krewski et al., 2009. Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. Health Effects Institute Research Report 140. <https://ephtracking.cdc.gov/docs/RR140-Krewski.pdf>.

<sup>104</sup> Gwynn, RC and Thurston, GD.,2001. The burden of air pollution: impacts among racial minorities. Environmental Health Perspectives;109(4):501–6. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240572/>.

<sup>105</sup> A detailed summary of the health modeling methodology is included in Appendix A of the CARB Proposed Regulatory Amendments to the Heavy-Duty Vehicle Inspection Program and Periodic Smoke Inspection Program SRIA. CARB, 2017. Proposed Regulatory Amendments to the Heavy-Duty Vehicle Inspection Program and Periodic Smoke Inspection Program SRIA. [http://www.dof.ca.gov/Forecasting/Economics/Major\\_Regulations/documents/CARB%20HDVIP%20PSIP%20SRIA.pdf](http://www.dof.ca.gov/Forecasting/Economics/Major_Regulations/documents/CARB%20HDVIP%20PSIP%20SRIA.pdf).

The majority of health benefits estimated in the proposed amendments scenario are concentrated in the South Coast and San Joaquin Valley air basins, with minor health benefits distributed among other regions. Because the LCFS does not specify the blend levels of alternative fuels used at different locations within the State and does not specify how or where the changing supplies of transportation fuels will be produced, the projections of the spatial distribution of emission reductions and associated health impacts from the proposed amendments is highly uncertain. This source of uncertainty is not accounted for in the 95 percent confidence intervals.

**Table V-12: Incremental (Relative to the 2016 Baseline) Regional and Statewide Avoided Mortality and Morbidity Incidences from 2019 to 2030 under the Proposed Amendments Scenario<sup>\*106</sup>**

Region	Avoided Premature Deaths	Avoided Hospitalizations	Avoided ER Visits
Great Basin Valleys	0 (0-0)	0 (0-0)	0 (0-0)
Lake County	1 (1-1)	0 (0-0)	0 (0-0)
Lake Tahoe	0 (0-0)	0 (0-0)	0 (0-0)
Mojave Desert	8 (6-10)	1 (0-3)	4 (2-5)
Mountain Counties	1 (1-1)	0 (0-0)	0 (0-0)
North Central Coast	2 (2-3)	0 (0-1)	1 (1-1)
North Coast	1 (1-1)	0 (0-0)	0 (0-0)
Northeast Plateau	0 (0-1)	0 (0-0)	0 (0-0)
Sacramento Valley	26 (21-32)	4 (1-9)	10 (6-14)
Salton Sea	8 (6-9)	1 (0-3)	2 (2-3)
San Diego County	21 (17-26)	4 (0-8)	9 (6-13)
San Francisco Bay	43 (34-53)	8 (1-18)	19 (12-26)
San Joaquin Valley	86 (67-105)	11 (1-25)	36 (22-49)
South Central Coast	8 (6-10)	1 (0-3)	3 (2-4)
South Coast	141 (111-173)	20 (3-47)	61 (38-83)
Statewide	348 (272-426)	51 (6-118)	146 (92-200)

\*Values in parenthesis represent the 95% confidence interval. Totals may not add due to rounding

## F. Localized Health Risk Assessment for a Potential California Biofuel Facility

When analyzing the health impacts of re-adopting the LCFS in 2015, staff conducted a health risk assessment (HRA) study to evaluate the localized health impacts associated with toxic air contaminants that could be emitted from a typical biofuel facility within California.

In order to estimate the potential cancer risk associated with a newly established biofuel facility, staff developed a prototype biofuel facility for a case study of Health Risk Assessment. Based on the size of some in-state biofuel facilities, staff assumed the

<sup>106</sup> The method used to quantify health benefits was used for CARB's on-road diesel regulations. Jet fuel emissions are treated the same as on-road diesel. This is an upper bound estimate. Fuel production emissions were discounted by a factor of 0.2 compared to diesel. In other words, PM emissions from this category were multiplied by 0.2. This factor is based on dispersion modeling work by Research Division, which suggests that the ratio of intake fractions of PM from refineries in Los Angeles to on-road diesel is approximately 1/5.

prototype facility to be located in a square 400-meter by 400-meter fence line. The emission sources from the facility include natural gas or biomass boilers and turbines. Diesel PM emissions are generally generated by the heavy-duty trucks that are used to transport feedstocks and finished biofuels.

Staff analyzed emission source characterization and parameters, collected meteorological data, conducted air dispersion modeling, and assessed potential cancer risks associated with the prototype biofuel facility based on *The Air Toxics Hot Spots Program Risk Assessment Guidelines*<sup>107</sup> published by the California Office of Environmental Health Hazard Assessment (OEHHA). The results of the health risk assessment indicated that, the area with the greatest impact has an estimated potential cancer risk of approximately 0.8 chances in a million, surrounding the fence lines. About 200 yards from the facility boundaries, the estimated cancer risks decrease to about 0.4 chances per million. The estimated potential cancer risks further decrease to about 0.2 chances per million at about 400 yards from the facility boundaries.

Staff also estimated the health impact associated with the combined onsite and offsite emissions of the prototype biofuel facility. The area with the greatest impact has an estimated potential cancer risk of approximately 5 chances in a million, mostly occurring directly adjacent to the main truck route that connects the prototype biofuel facility and the major freeway. At about 200 yards from the truck route, the estimated cancer risk drops to about 2 chances per million. At about 500 yards from the truck routes, the estimated cancer risk further decreases to about 1 chance per million.

For additional details, please see Chapter IV of the 2015 ISOR of the LCFS<sup>108</sup>.

### **G. Analysis Performed Relative to Low Carbon Fuel Standard Targets Remaining Constant at 10 Percent Reduction from 2021 to 2030**

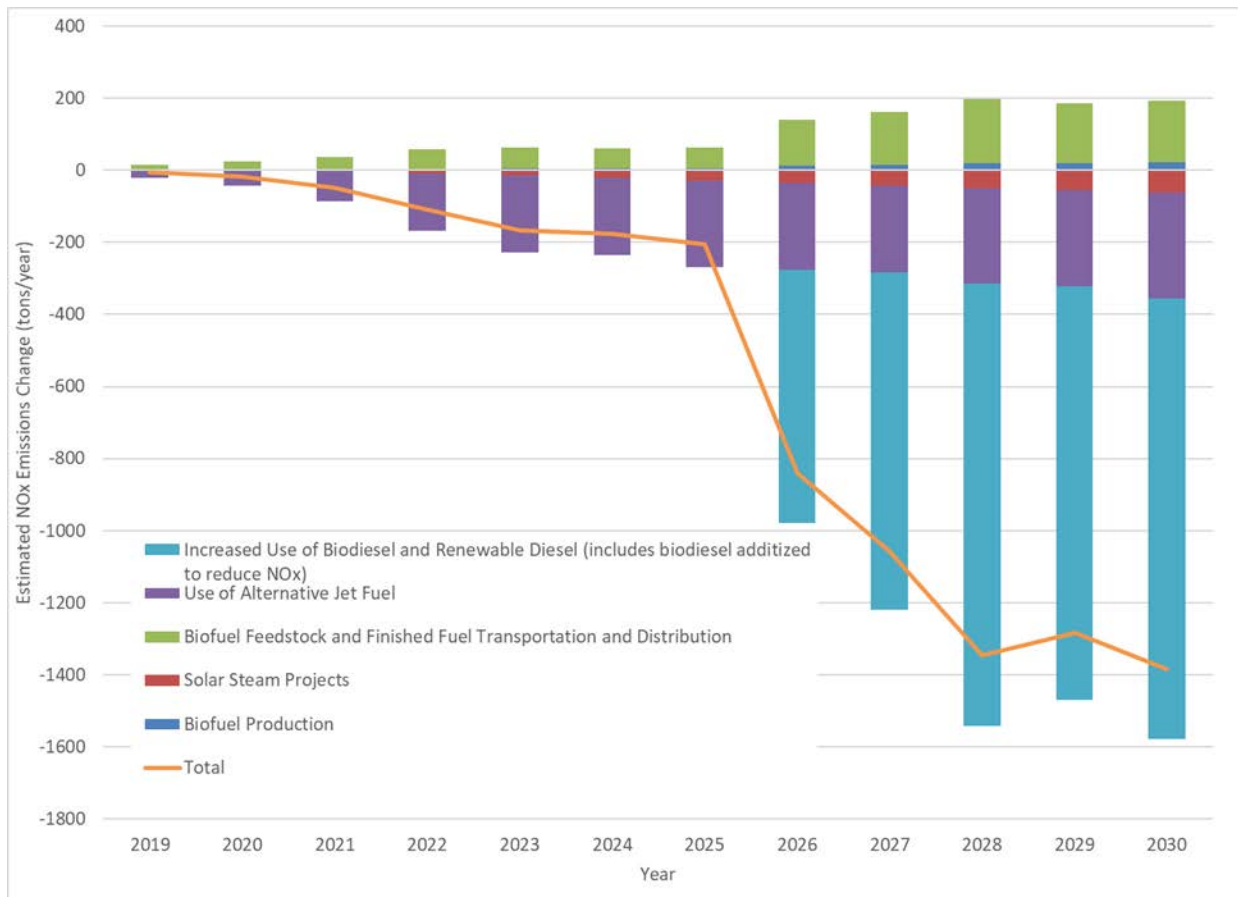
For the purposes of full disclosure, staff performed the same analysis comparing the proposed amendments to the projected emissions impact of a LCFS program that remains at 10 percent CI reduction post 2020. This represents a comparison to a business-as-usual scenario that may occur without adoption of the proposed amendments. More details on the business-as-usual scenario, including estimated volumes of alternative fuels and implementation of petroleum projects, are presented in Appendix E of the Staff Report. The net NO<sub>x</sub> and PM<sub>2.5</sub> emissions impact of the proposed amendments relative to the 10 percent LCFS scenario are presented in Figures V-12 and V-13, respectively. The total statewide NO<sub>x</sub> and PM<sub>2.5</sub> emissions are estimated to be lower in each year from 2019 through 2030. More details on this analysis including a discussion of the health impacts is presented in Appendix E.

---

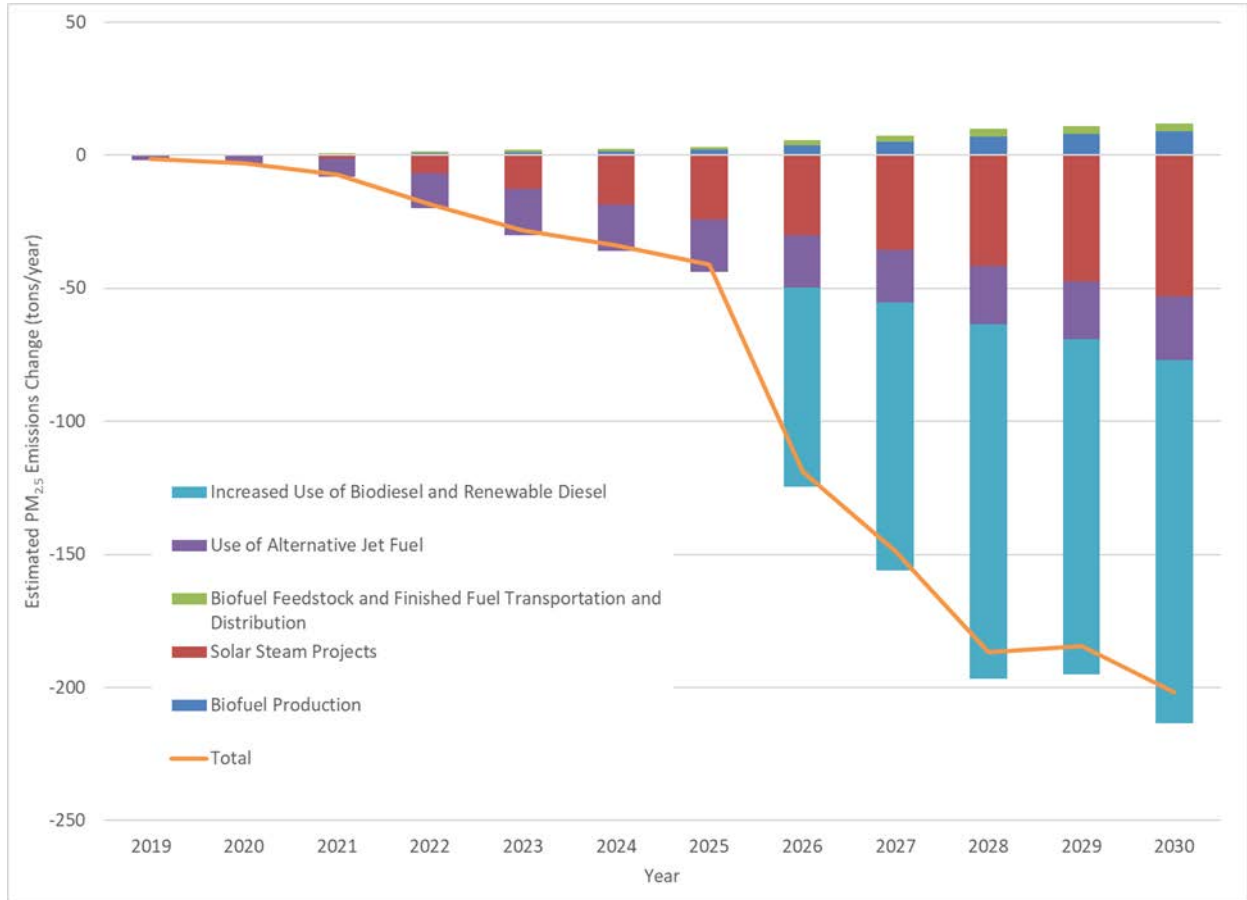
<sup>107</sup> Office of Environmental Health Hazard Assessment. February 2015. *Air Toxics Hot Spots Program Risk Assessment Guidelines*. Available at: [http://oehha.ca.gov/air/hot\\_spots/pdf/HRAguidefinal.pdf](http://oehha.ca.gov/air/hot_spots/pdf/HRAguidefinal.pdf)

<sup>108</sup> Staff Report: Initial Statement of Reasons for Rulemaking: Proposed Re-adoption of the Low Carbon Fuel Standard Regulation." December 31 (2014). Available at: <https://www.arb.ca.gov/regact/2015/lcfs2015/lcfs15isor.pdf>

**Figure V-12: Estimated Statewide NOx Emissions Impact of the Proposed LCFS Amendments Relative to the LCFS at 10 Percent (tons/year)**



**Figure V-13: Estimated Statewide PM<sub>2.5</sub> Emissions Impact of the Proposed LCFS Amendments Relative to the LCFS at 10 Percent (tons/year)**



## **VI. ENVIRONMENTAL ANALYSIS**

The California Air Resources Board (CARB), as the lead agency for the proposed regulation, has prepared an environmental analysis under its certified regulatory program (Cal. Code Regs., tit. 17, §§ 60000 through 60008) to comply with the requirements of the California Environmental Quality Act (CEQA). CARB's regulatory program, which involves the adoption, approval, amendment, or repeal of standards, rules, regulations, or plans for the protection and enhancement of the State's ambient air quality has been certified by the California Secretary for Natural Resources under Public Resources Code section 21080.5 of CEQA (Cal. Code Regs., tit. 14, § 15251(d)). CARB, as a lead agency, prepares a substitute environmental document (referred to as an "Environmental Analysis" or "EA") as part of the Staff Report to comply with CEQA (Cal. Code Regs., tit. 17, § 60005).

The Draft Environmental Analysis (Draft EA) for the proposed LCFS and ADF amendments is included in Appendix D to this Staff Report. The Draft EA provides a programmatic environmental analysis of an illustrative, reasonably foreseeable compliance scenario that could result from implementation of the proposed amendments for the LCFS and ADF regulations.

The Draft EA states that implementation of the proposed amendments could result in beneficial impacts to GHGs through substantial reductions in emissions from transportation fuels in California from 2019 through 2030 and beyond and beneficial impacts to energy demand.

For the purpose of determining whether the proposed amendments have a potential adverse effect on the environment, CARB evaluated the potential physical changes to the environment resulting from a reasonable foreseeable compliance scenario for the proposed amendments. Approval and implementation of the proposed amendments would result in an LCFS with the revisions described above. The environmental effects of the proposed LCFS amendments would, therefore, build upon the compliance responses of the current LCFS regulation. In many instances, compliance responses associated with the proposed amendments would be a variation of actions that are already occurring.

Implementation of the proposed amendments is anticipated to provide incentives for various projects, including: modifications to cultivation volume and transport of feedstock; changes to location and types of feedstock; new or modified processing facilities for feedstock and finished fuel production; increased transportation of finished alternative fuels to blending terminals or retail fuel sites; construction and operation of new facilities to produce renewable diesel, gasoline, AJF, and propane; construction of new anaerobic facilities to digest manure from dairies, sewage from wastewater treatment plants, and organic waste diverted from landfills; construction of infrastructure to collect biogas and produce methane; construction of stand-alone and bolt-on cellulosic processing units for renewable fuels production; increase of tree cultivation at farms, collection of yard waste, or removal of forest litter and agricultural residues; construction of electrolysis units and substitution of renewable natural gas for fossil gas

in production of hydrogen; construction of solar and wind electricity generation projects; modification to existing or new industrial facilities to capture CO<sub>2</sub> emissions; construction of new infrastructure such as pipelines, wells and other surface facilities; construction and operation of additional hydrogen stations, CNG/LNG stations and EV charging stations; deployment and use of additional electric drivetrain, natural gas, and propane fueled vehicles; modifications to existing crude production facilities to accommodate solar and wind electricity, solar heat, and/or solar steam generation; electrification of equipment and installation of renewable electricity at petroleum refineries and alternative fuel production facilities; land use changes and changes to fuel-associated shipment patterns..

While many impacts associated with the proposed amendments could be reduced to a less-than-significant level through conditions of approval applied to project-specific development, the authority to apply that mitigation lies with land use agencies or other agencies approving the development projects, not with CARB. Consequently, the EA takes the conservative approach in its significance conclusions and discloses, for CEQA compliance purposes, that impacts from the development of new facilities or modification of existing facilities associated with reasonably foreseeable compliance responses to the proposed regulations could be potentially significant and unavoidable. Table VI-1 below summarizes potential impacts of approving the proposed amendments.

**Table VI-1. Summary of Potential Environmental Impacts**

<b>Resource Area Impact</b>	<b>Significance</b>
Short-Term Construction-Related and Long-Term Operational Impacts on Aesthetics	Potentially Significant and Unavoidable
Conversion of Agricultural and Forest Resources Related to New Facilities	Potentially Significant and Unavoidable
Agricultural and Forest Resource Impacts Related to Feedstock Cultivation	Potentially Significant and Unavoidable
Short-Term Construction-Related Air Quality Impacts	Potentially Significant and Unavoidable
Long-Term Operation Air Quality Emissions	Potentially Significant and Unavoidable
Short-Term Construction-Related and Long-Term Operational Impacts from Odors	Less Than Significant
Short-Term Construction-Related and Long-Term Impacts on Biological Resources Related to New Facilities	Potentially Significant and Unavoidable
Effects of Biological Resources Associated with Land Use Changes	Potentially Significant and Unavoidable
Short-Term Construction-Related and Long-Term Operational Impacts on Cultural Resources	Potentially Significant and Unavoidable
Short Term Construction-Related Impacts on Energy Demand	Less Than Significant
Long-Term Operational Impacts on Energy Demand	Beneficial



<b>Resource Area Impact</b>	<b>Significance</b>
Short-Term Construction-Related and Long-Term Operational Effects on Geology and Soil Related to New Facilities	Potentially Significant and Unavoidable
Long-Term Operational Impacts to Geology and Soil Associated with Land Use Changes	Potentially Significant and Unavoidable
Short-Term Construction- and Long-Term Operational Related Greenhouse Gas Impacts	Beneficial
Short-Term Construction-Related Hazard Impacts	Potentially Significant and Unavoidable
Long-Term Increased Transport, Use, and Disposal of Hazardous Materials	Less Than Significant
Short-Term Construction-Related and Long-Term Operational Hydrologic Resource Impacts	Potentially Significant and Unavoidable
Long-Term Effects on Hydrology and Water Quality Related to Changes in Land Use	Potentially Significant and Unavoidable
Short-Term Construction-Related Impacts Related to New or Modified Facilities	Potentially Significant and Unavoidable
Long-Term Operational Impacts Related to Feedstock Production	Potentially Significant and Unavoidable
Short-Term Construction-Related Impacts on Mineral Resources	Less Than Significant
Long-Term Operational-Related Impacts on Mineral Resources	Potentially Significant and Unavoidable
Short-Term Construction-Related Noise Impacts	Potentially Significant and Unavoidable
Long-Term Operational Noise Impacts	Potentially Significant and Unavoidable
Short-Term Construction-Related Impacts and Long-Term Operational Impacts on Population, Employment, and Housing	Less Than Significant
Short-Term Construction-Related Impacts and Long-Term Operational Impacts on Public Services	Less Than Significant
Short-Term Construction-Related Impacts and Long-Term Operational Impacts on Recreation	Less Than Significant
Short-Term Construction-Related Impacts on Traffic and Transportation	Potentially Significant and Unavoidable
Long-Term Operational Impacts on Traffic and Transportation	Potentially Significant and Unavoidable
Increased Demand for Water, Wastewater, Electricity, and Gas Services	Potentially Significant and Unavoidable

Written comments on the Draft EA will be accepted starting March 9, 2018 through 5 p.m. on April 23, 2018. The Board will consider the final EA and responses to

comments received on the Draft EA before taking action to adopt the proposed amendments.

## VII. ENVIRONMENTAL JUSTICE

**Overview.** For nearly two decades, CARB has been committed to making environmental justice (EJ) an integral part of its rulemaking, policy development and other key decision-making and implementation activities. Since adopting the LCFS in 2009, CARB has incorporated into the program a number of key EJ-related recommendations provided by the AB 32 Environmental Justice Advisory Committee (EJAC). In the current rulemaking, we are working with CARB's recently-appointed Assistant Executive Officer for Environmental Justice to effectuate the most recent EJAC recommendations<sup>109</sup> on a wide variety of areas, including the LCFS, as well as EJ-related recommendations on the LCFS provided by disadvantaged community representatives<sup>110</sup> throughout CARB's extensive 2015-2017 community engagement process.<sup>111</sup>

**What is Environmental Justice?** State law defines environmental justice as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies.<sup>112</sup> The Board approved its Environmental Justice Policies and Actions (Policies) in 2001<sup>113</sup> to establish a framework for incorporating environmental justice into CARB's programs consistent with State law. These policies and actions apply to all communities in California but are especially applicable in the context of low-income and minority communities.

### A. LCFS, Climate Change Scoping Plan, and Related Environmental Justice Efforts to Date

Assembly Bill 32 (AB 32, Nunez, Stats. 2006, ch. 488) requires CARB to develop a Scoping Plan for achieving the maximum technologically feasible and cost-effective reductions in GHG emissions from sources by 2020. The Scoping Plan builds on past successes and describes the approach California will take to achieve its GHG emission reduction goals; it includes many different policies and strategies, including the LCFS, to

---

<sup>109</sup> See Priority EJAC Recommendations, <https://www.arb.ca.gov/cc/ejac/meetings/05262017/priority-ejac-recommendations-carb-responses052017.pdf>.

<sup>110</sup> See [https://www.arb.ca.gov/cc/scopingplan/2030sp\\_appa\\_ejac\\_final.pdf](https://www.arb.ca.gov/cc/scopingplan/2030sp_appa_ejac_final.pdf), which were consolidated from over 700 individual suggestions gathered from community members during the 2015-2017 community meetings.

<sup>111</sup> See <https://www.arb.ca.gov/ejac> for list of nearly three dozen EJAC and local community meetings held from December 2015 through November 2017 in various communities throughout California.

<sup>112</sup> SB 115 (Solis, Stats. 1999, ch. 690), which added Government Code, section 65040.12, subdivision (c).

<sup>113</sup> See <https://www.arb.ca.gov/ch/programs/ej/ejpolicies.pdf>.

address different sources of GHGs from different sectors of the economy. The first Scoping Plan was adopted in 2008 and updated twice since then.<sup>114,115</sup>

The LCFS was adopted in 2009 as a discrete early action GHG-reduction measure,<sup>116</sup> and each iteration of the Scoping Plan has included the LCFS within its framework. It remains California's primary strategy for promoting the use of cleaner alternative fuels, including electricity, hydrogen, renewable diesel and biodiesel, and renewable natural gas. As noted, the Legislature enacted SB 32 in 2016, which codifies a 2030 GHG emissions reduction target of 40 percent below 1990 levels. With this new, lower GHG target, the LCFS will continue to play an important role in California's climate change program, and we are committed to ensuring that the tightening of the LCFS standards to achieve the SB 32 target will continue to further our EJ-related efforts.

Among its various provisions, AB 32 also requires CARB to convene an Environmental Justice Advisory Committee (EJAC) to advise the Board during the development and subsequent updates of the Scoping Plan. The EJAC consists of representatives of communities in the State with significant exposure to air pollution, including disadvantaged communities with minority or low-income populations. For the original 2008 Scoping Plan (and subsequent adoption of the LCFS) and the 2014 First Scoping Plan Update, EJAC provided several recommendations relating to the LCFS; a number of which were addressed through the design and implementation of the LCFS. To illustrate, EJAC raised a number of concerns as part of the 2009 LCFS rulemaking that were related to the siting of biorefineries in California, especially if such facilities were sited near disadvantaged communities. In response, CARB adopted a biorefinery siting guidance so that local decision-makers can make better informed siting determinations.<sup>117</sup>

While adoption of the biorefinery siting guidance addressed some EJAC concerns, the guidance alone does not eliminate EJAC concerns about potential increases in criteria and other pollutants from increased alternative fuel production attributable to the LCFS amendments. As discussed in Chapter V, Air Quality, the proposed amendments are expected to result in an increase in production and/or expansion at California alternative fuel facilities, which may result in increased NO<sub>x</sub> and PM<sub>2.5</sub> emissions at these facilities.

---

<sup>114</sup> First Scoping Plan Update, see [https://www.arb.ca.gov/cc/scopingplan/2013\\_update/first\\_update\\_climate\\_change\\_scoping\\_plan.pdf](https://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf).

<sup>115</sup> 2017 GHG Scoping Plan Update to establish framework for achieving the 2030 GHG reduction target of 40% relative to 1990 levels set by SB 32 (Pavley, Stats. 2016, ch. 249), see [https://www.arb.ca.gov/cc/scopingplan/scoping\\_plan\\_2017.pdf](https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf).

<sup>116</sup> Pursuant to H&S sec. 38560.5.

<sup>117</sup> See <https://www.arb.ca.gov/fuels/lcfs/bioguidance/biodocs/finalbiorefineryguidenov2011.pdf> adopted in November 2011. See [https://www.arb.ca.gov/cc/ejac/meetings/041309/ejac\\_lcfs\\_recs\\_4-21-09.pdf](https://www.arb.ca.gov/cc/ejac/meetings/041309/ejac_lcfs_recs_4-21-09.pdf) for additional EJAC recommendations regarding the LCFS program. These recommendations were considered by the Board and determined to be addressed through the design and/or public vetting and scientific peer review of the LCFS regulation or otherwise addressed by other CARB programs and policies; see Board Resolution 09-31, <https://www.arb.ca.gov/regact/2009/lcfs09/res0931.pdf>.

Potential emission increases are required to be addressed through the existing statutory and regulatory framework implemented by the local air districts to control air emissions from stationary sources like biorefineries and petroleum refiners. Further, as discussed in Chapter V, emissions from stationary sources will be monitored and controlled by local air districts to minimize the negative impacts from the increased production. And the State Implementation Plans (for attaining ambient air quality standards) and AB 617 programs to be implemented by the air districts and CARB will ensure that any increase in criteria pollutant emissions – from increased activity due to the proposed amendments – will be controlled to minimize the impacts on California residents, especially in areas with poor air quality.

For the 2014 First Scoping Plan Update, EJAC recommended, among other things,<sup>118</sup> that the carbon intensity of the drilling and hydraulic fracturing (“fracking”) of shale oil be assessed as part of the LCFS. This recommendation has since been integrated into the LCFS through CARB’s adoption of the Oil Production GHG Emissions Estimator (OPGEE), a software module designed to assess the carbon intensity of such crude production activities.<sup>119</sup> Further, CARB approved at its March 2017 hearing a regulation on GHG emission standards for crude oil and natural gas facilities, which also imposes emission standards on fracking activities,<sup>120</sup> further addressing the underlying concerns with regard to accurate accounting of the carbon intensity of fracking and drilling activities.

In support of EJAC’s mission to advise CARB on the 2017 Scoping Plan Update, CARB staff facilitated and participated in an extensive series of meetings around the State. These meetings were conducted to engage local residents and representatives of disadvantaged communities with informational sessions and world café<sup>121</sup> style discussions to solicit their input on the 2017 Scoping Plan Update under development at that time. Since the 2017 Scoping Plan Update includes and builds on the LCFS, it was a topic of discussion at each of the dozen community meetings held around the State. CARB staff collected and compiled the recommendations gathered at the meetings, and after several robust discussions in public meetings, EJAC submitted to CARB their recommendations, which incorporated the recommendations collected from the local community meetings.

The EJAC recommendations related to the proposed LCFS rulemaking will be addressed later in this chapter. It should be noted that the LCFS-specific comments, raised at the community and EJAC meetings, constituted a very small portion of the overall EJ-related comments on the 2017 Scoping Plan Update. The majority of the recommendations compiled were directed toward other programs and policies in California’s portfolio of GHG policies and are outside the scope of the current LCFS

---

<sup>118</sup> See [https://www.arb.ca.gov/cc/ejac/meetings/041014/appendix\\_a.pdf](https://www.arb.ca.gov/cc/ejac/meetings/041014/appendix_a.pdf) for a complete list of EJAC recommendations for the First Scoping Plan Update.

<sup>119</sup> See <https://www.arb.ca.gov/fuels/lcfs/crude-oil/crude-oil.htm>.

<sup>120</sup> See <https://www.arb.ca.gov/regact/2016/oilandgas2016/oilandgas2016.htm>.

<sup>121</sup> See, e.g., <http://www.theworldcafe.com/key-concepts-resources/world-cafe-method/>.

rulemaking. It should also be noted that the many strategies and policies in this portfolio, and the Scoping Plan, are designed to work together to address the complicated issues of climate change and environmental justice.

## **B. EJ Overview on the Current LCFS Program**

In its overarching recommendations for the 2017 Scoping Plan Update, EJAC recommended for the transportation sector:<sup>122</sup>

*“We envision a California where all communities breathe clean air and have access to safe, affordable, clean transportation options. The following recommendations will help to achieve this vision. The themes present in this Transportation Section that can be lifted up as overarching principles are:*

- a. Access to clean transportation technologies*
- b. Meaningful investments in disadvantaged communities*
- c. Capturing economic benefits in disadvantaged communities*
- d. Coordination of state and local agencies*
- e. Reporting on actual impacts of programs, particularly community level impacts*
- f. Robust community participation.”*<sup>123</sup>

The remainder of this chapter will demonstrate how the LCFS supports several of the EJAC’s overarching principles listed above for the transportation sector in the 2017 Scoping Plan Update.

As noted, the fundamental goal of the LCFS is to reduce the carbon intensity (and therefore GHG emissions) of transportation fuels used in California. The LCFS achieves this fundamental goal, while acknowledging the concerns voiced by EJAC. After eight years of implementation, the LCFS has incented significant lower-carbon fueling infrastructure developments in California and elsewhere. The current LCFS program includes the following in-state credit generating entities:<sup>124</sup>

- Two biomethane production facilities, which are dedicated for vehicle use;
- Two renewable diesel production facilities;

---

<sup>122</sup> The EJAC has submitted more recent overarching recommendations for the 2030 Scoping Plan. However, the most recent recommendations were less relevant to the LCFS, than the overarching recommendations dated December 22, 2016. Their most recent recommendations can be found in Appendix A of the 2030 Scoping Plan.

<sup>123</sup> AB 32 Environmental Justice Advisory Committee (EJAC) Recommendations for Proposed 2017 Scoping Plan Update, [https://www.arb.ca.gov/cc/ejac/ejac\\_recommendations\\_proposed\\_plan122216.pdf](https://www.arb.ca.gov/cc/ejac/ejac_recommendations_proposed_plan122216.pdf).

<sup>124</sup> See “LCFS Data Dashboard Website, Figure 11 - Underlying Data Table,” as of the end of Q3 2017, [https://fusiontables.google.com/data?docid=1844ojN\\_mpAEEjaL4hu5yvkwmUyNVcartNO2s\\_SMS#map:id=3](https://fusiontables.google.com/data?docid=1844ojN_mpAEEjaL4hu5yvkwmUyNVcartNO2s_SMS#map:id=3).

- Five ethanol production facilities;
- Nine biodiesel production facilities;
- One innovative crude production method project providing solar steam for thermal enhanced oil recovery;
- Six transit agencies that generate LCFS credits from electrified fixed guideways such as light rail, heavy rail, cable cars, street cars, and trolley buses;
- 13 electrical utilities that receive LCFS credits generated from non-metered residential electric vehicle (EV) charging and electric forklift charging occurring within the utility's service territory and return the revenue from these credits to EV users;
- 18 hydrogen-fueling stations;<sup>125</sup>
- 79 EV charging stations controlled by a transit agency or similar entities that receive LCFS credit for reinvestment in new vehicles and infrastructure, or to decrease the operating costs of their fleet;
- 84 electric forklift fleets that generate LCFS credits from metered electric forklift fleet charging;
- 345 compressed natural gas (CNG) fueling stations that service larger vehicles such as transit buses; and
- 7,529 general electric vehicle (EV) charging stations. Providers of public charging for EVs receive LCFS credit that they may use to build more stations or reduce the costs for customers to charge.

One of EJAC's principal recommendations regarding transportation is for the State to provide and facilitate "*access to clean transportation technologies.*"<sup>126</sup> This recommendation encompasses, among other things, increasing the availability of electric vehicles and charging infrastructure in disadvantaged communities. As noted, the LCFS program covers nearly 8,000 registered EV charging stations that receive LCFS credits. Some of these are in urban centers in, or near, disadvantaged communities. These EV charging stations (vehicle, fleet, or equipment i.e., forklifts) are considered a net air quality benefit for any community where they are located. A similar determination would apply to hydrogen and natural gas fuel-dispensing stations.

Generally, the disadvantaged community representatives that were involved in the 2015-2017 community engagement process recommended more, not less, EV charging infrastructure in their communities. By incentivizing the use of charging stations for public, private, transit, and fleet uses, the LCFS supports this principal goal. However, it should be noted that most EV charging stations are currently located in areas with the highest number of electric vehicles, which are usually not in disadvantaged

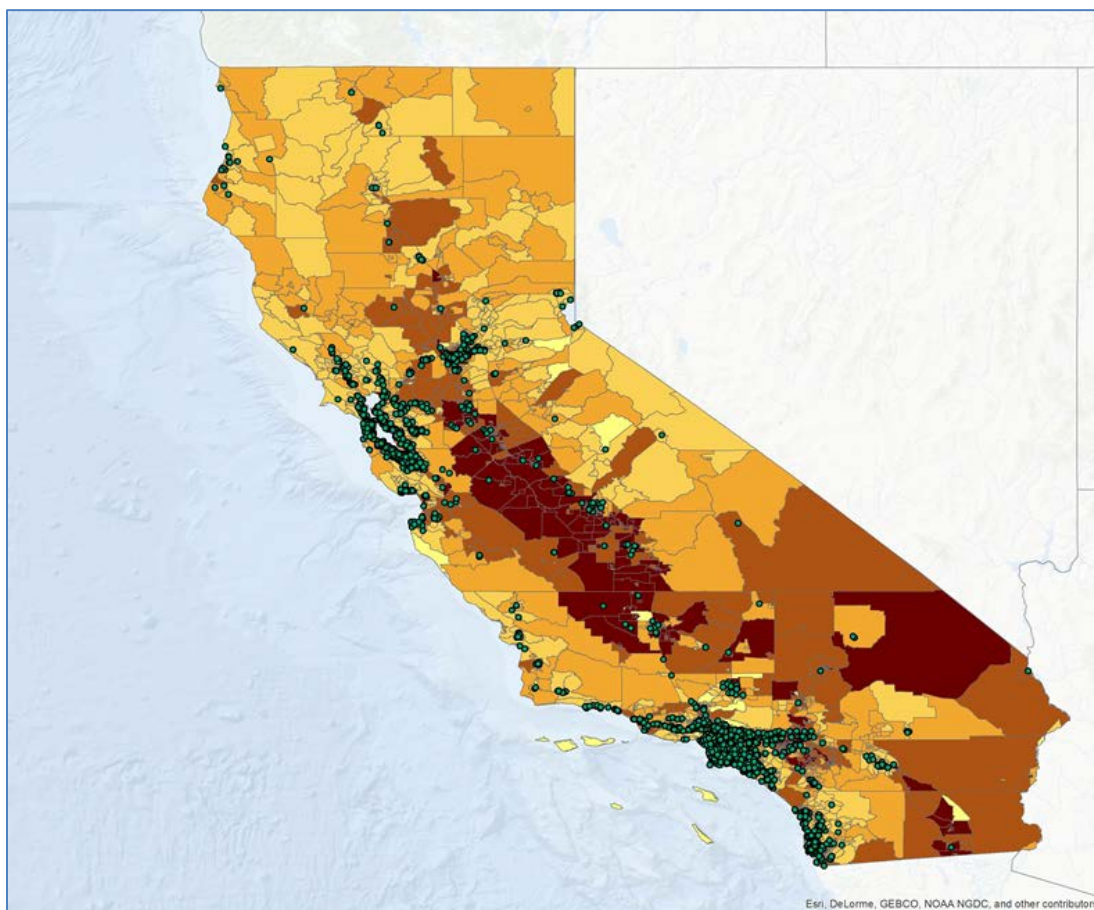
---

<sup>125</sup> As of February 1, 2018, there were 31 hydrogen-fueling stations that are operational and dispensing hydrogen fuel, but not all of them had been registered or generating credits under the LCFS as of the end of Q3 2017. See California Fuel Cell Partnership, [https://cafcp.org/by\\_the\\_numbers](https://cafcp.org/by_the_numbers).

<sup>126</sup> AB 32 Environmental Justice Advisory Committee (EJAC) Recommendations for Proposed 2017 Scoping Plan Update, [https://www.arb.ca.gov/cc/ejac/ejac\\_recommendations\\_proposed\\_plan122216.pdf](https://www.arb.ca.gov/cc/ejac/ejac_recommendations_proposed_plan122216.pdf).

communities. Figure VII-1 below shows the location of EV charging stations in the State and the need for more EV charging infrastructure in disadvantaged communities (the darker areas indicate a community with higher environmental burdens as indicated by CalEnviroScreen 3.0<sup>127</sup>). While the LCFS does not provide specific incentives for siting EV charging stations in disadvantaged communities, other programs that do may rely on the value of LCFS credits to make their efforts feasible.

**Figure VII-1: Location of EV Charging Stations**



Source: LCFS Dashboard map, <https://www.arb.ca.gov/fuels/lcfs/dashboard/map.html>, overlay on CalEnviroScreen 3.0, *op cit*.

The use of conventional biofuels like ethanol and biodiesel has grown, partly due to the LCFS, and has generally provided air quality co-benefits in addition to the intended GHG reductions.<sup>128</sup> A common burden on certain disadvantaged communities located

<sup>127</sup> See <https://oehha.maps.arcgis.com/apps/webappviewer/index.html?id=4560cfbce7c745c299b2d0cbb07044f5>.

<sup>128</sup> Historically, biodiesel driven by the LCFS may have created minor health impacts associated with NOx disbenefits but strong health improvements associated with reduced PM co-benefits, as explained in the



near transportation and freight movement hubs is exposure to particulate matter (PM) and other air pollutants from the tailpipe emissions of vehicles and trucks. Although the LCFS addresses only the GHG emissions, studies have shown that biodiesel and renewable diesel generally both have lower emissions of other pollutants, including PM, than petroleum diesel.<sup>129</sup> Because the LCFS incents the use of more low carbon fuels like biodiesel, renewable diesel, renewable natural gas, hydrogen, and electricity, the LCFS reduces GHG emissions while helping reduce PM emissions and achieve other co-benefits.

The EJAC and EJ community representatives have also recommended that CARB help improve the affordability and quality of services of public transit agencies. Currently, there are transit agencies participating in the LCFS program that generate credits. These credits are sold by the transit agencies, which use the proceeds to help improve services and affordability for service users. The provisions in the LCFS allowing transit agencies to generate credits serve as an example of how CARB's policies promote zero and near-zero emission transit options for low income Californians.

### **C. The Proposed LCFS Amendments**

The proposed amendments will increase demand for low carbon fuels. As mentioned, this is a key recommendation from EJ representatives and their communities, of all types (rural, urban, and sub-urban) and in all regions of the State. Staff's analysis of the proposed amendments included development of an illustrative compliance scenario; see Figure V-3 in the Air Quality chapter of this Staff Report which shows the potential quantities of fuels that may be used to comply with a 20 percent reduction in carbon intensity by 2030.

The use of conventional biofuels for transportation will grow moderately, in part, because of these amendments. However, in the scenario shown in Figure V-3, starch ethanol use would decrease as the use of fuels with lower GHG emissions increases. Under that scenario, sugar ethanol use would also decline after a brief growth period.

Disadvantaged communities near freight corridors are negatively impacted by tailpipe emissions from trucks and other freight vehicles. Advanced biofuels, typically the cleanest transportation fuels available, will experience much greater growth percentages in this scenario under the proposed LCFS and Alternative Diesel Fuel (ADF) amendments. Renewable diesel use as a transportation fuel will increase significantly by 2030, and will provide GHG, PM, NOx and other emissions reduction co-benefits to disadvantaged communities. Other Scoping Plan policies, focused on zero emission technologies, for example, further reduce emissions near these freight and transportation corridors.

---

supplemental disclosure, Appendix G of this Staff Report. On a forward-going basis, the ADF rule eliminates any potential NOx disbenefits from biodiesel.

<sup>129</sup> See <https://calepa.ca.gov/wp-content/uploads/sites/62/2016/10/CEPC-2015yr-Presentation.pdf>.

CARB staff has also heard concerns about particulate emissions from the residents of disadvantaged communities living near airports. Since airports and aviation fall under federal regulatory jurisdiction, incentivizing the use of cleaner jet fuels with fewer emissions than traditional jet fuels is one way California is helping residents near these facilities. The proposed amendments will permit alternative jet fuels to generate LCFS credits, thus incentivizing their use and yielding the accompanying PM reduction co-benefits. These emissions reductions are greatest during landings, take-offs, and the taxiing of the plane on the airstrip; providing direct PM emissions reductions to the residents of communities near airports.

The proposed amendments will also help drive increases in the use of electricity and hydrogen as transportation fuels. As noted above, there are many transit and municipal service agencies generating credits from electricity already, as well as company fleets, and privately-owned charging stations. Other CARB policies and programs are also in effect to incentivize the use of zero and near-zero emission technologies. Collectively, they are accelerating the growth of electricity and hydrogen as transportation fuels.

Another source of GHG reductions in the LCFS is the use of solar steam projects for oil recovery. Presently, much of California's oil is being extracted using steam that is generated through combustion of fossil fuels, adding to the extracted oil's carbon intensity. Enhancing support for solar steam projects for oil recovery in the LCFS will incentivize the use of solar energy, in lieu of combustion, to generate steam. This will reduce GHG emissions, as well as other emissions like PM and NOx that result from combustion; such emission reductions will be helpful in reducing NOx and PM emissions in communities near oil fields, which are mostly in the San Joaquin Valley.

There were also EJ-related concerns raised involving dairy digesters and their production of biomethane (renewable natural gas) for use as a transportation fuel. Staff believes that the LCFS incentivizes pipeline injection of captured biomethane in place of flaring or electricity production; therefore, criteria pollutant and air toxic emissions that otherwise would have occurred on-site through combustion at the dairy for power generation would be avoided or otherwise reduced. The SRIA for the proposed LCFS amendments discusses new dairy digester projects by 2030 that will result in capture and pipeline injection of biomethane for eventual use in natural gas vehicles. The Greenhouse Gas Reduction Fund Investment Plan includes an investment principle that the expenditure of auction proceeds should complement efforts to improve air quality, and supports funding for dairy digesters.

In addition, CARB convened and is currently overseeing, with sister agencies, a dairy digester workgroup<sup>130</sup> to identify methane reduction approaches that can minimize impacts to disadvantaged communities, among other goals. SB 1383 (Lara, Stats. 2016, ch. 395) codified CARB's Short-Lived Climate Pollutant Reduction Strategy<sup>131</sup> in order to achieve reductions in the statewide emissions of short-lived climate pollutants,

---

<sup>130</sup> See <https://www.arb.ca.gov/cc/shortlived/shortlived.htm>.

<sup>131</sup> Ibid.

including methane, to help reduce the many impacts of climate change in some of California's most disadvantaged communities. Reducing these methane emissions can have an immediate beneficial impact on climate change; methane is a powerful climate forcer that remains in the atmosphere for a much shorter period than longer-lived climate pollutants, such as CO<sub>2</sub>.

#### **D. Carbon Capture and Sequestration (CCS)**

Carbon capture and sequestration is a potentially critical contributor to reaching California's greenhouse gas reduction goals, but CARB recognizes the concerns of communities near these facilities. The EJAC raised concerns regarding CCS project impacts on disadvantaged communities.

The proposed CCS Protocol allows CCS projects to receive credit under the LCFS only if they can meet the protocol's rigorous framework. Staff have developed a robust conservative approach that emphasizes proper site selection and well construction integrity and requires risk assessment and risk reduction, geophysical modeling, and on-site monitoring out to 100 years. But compliance with the proposed CCS Protocol is just one of a number of State, local, and federal requirements that a CCS project may be subject to; CARB implementation of the CCS Protocol does not supersede or eliminate a CCS project applicant's/operator's obligation to comply with all applicable State, local, and federal requirements (e.g., California Environmental Quality Act, State water quality regulations, federal underground injection rules, etc.).

Some of the first CCS projects under the LCFS are expected to be at existing ethanol facilities because ethanol plants have relatively pure CO<sub>2</sub> streams that do not require much energy to capture. These facilities will not require as much energy to capture the CO<sub>2</sub> as most other CO<sub>2</sub> capture types. Although enhanced oil recovery projects are eligible to receive credit, the necessarily rigorous well-construction, remediation, and monitoring requirements are likely to make these sites more costly and therefore limit participation of such projects. The proposed CCS Protocol would also credit direct air capture, using chemical separation of CO<sub>2</sub> from air, providing credit for "negative emission" units. Direct air capture technologies can remove CO<sub>2</sub> from the atmosphere independent of any industrial activity. Overall, the proposed CCS Protocol is expected to incent projects to reduce GHG emissions, potentially providing negative carbon emissions, but only those projects that can meet the stringent requirements – including site characterization and selection, along with risk assessment and reduction, modeling, and on-site monitoring – will be credited. And as noted above, meeting the proposed CCS Protocol does not relieve a CCS project applicant/operator from its obligations to meet all other applicable State, local, and federal requirements.

#### **E. Conclusion**

Many elements of the Low Carbon Fuel Standard support key environmental justice-related recommendations, including the reduction of fossil fuel use and promotion of cleaner, low carbon fuels. Further, CARB has continually enhanced the LCFS since

2010 to further integrate EJ considerations into the LCFS program. The proposed LCFS rulemaking package continues this historical integration of EJ perspectives. And the LCFS complements other State policies as part of a suite of policies in California's portfolio of strategies to address climate change and its disproportionate burdens on disadvantaged communities.

## VIII. ECONOMIC IMPACTS ANALYSIS

### A. Overview

In this chapter, staff provides a summary of the economic impacts of the proposed amendments to the LCFS and ADF regulations. Greater details on the calculations and assumptions used to perform this analysis are included in Appendix E – Revised SRIA to the LCFS 2018 Amendments.

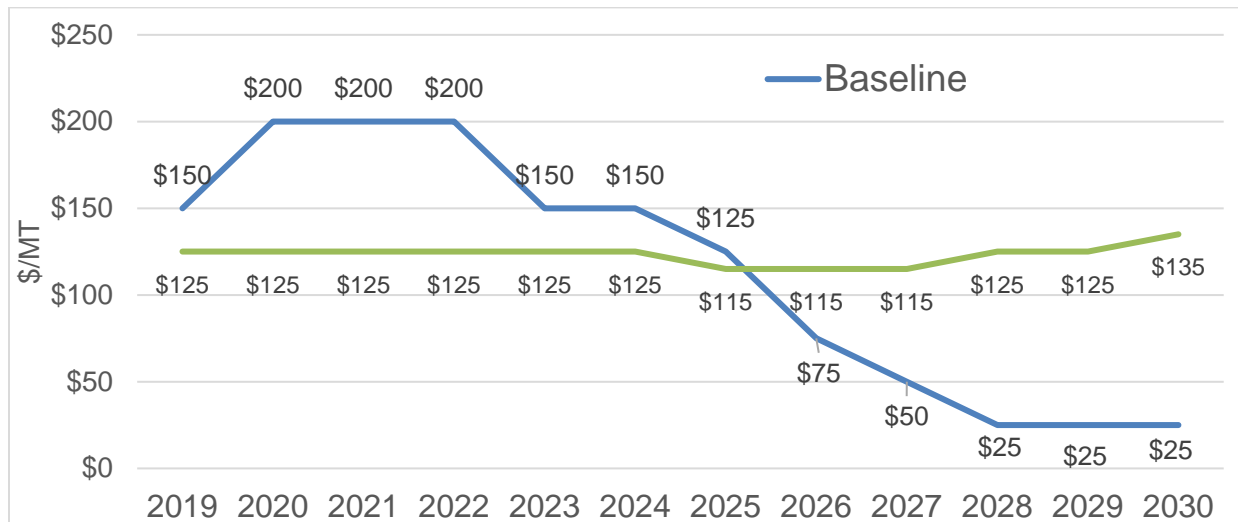
The most significant change under consideration in this rulemaking is how to strengthen the CI reduction targets through 2030 in-line with the SB 32 goals. The proposed amendments target a 20 percent reduction in fuel CI from a 2010 baseline by 2030. The amendments also propose smoothing the near-term benchmark schedule by linearly reducing by 1.25 percent annually from a 5 percent reduction in 2018 to the 20 percent value in 2030.

The LCFS credit price plays a large role in the economic impact of the proposed amendments. As both the fuel mix and the implementation of petroleum projects is different in the baseline scenario and under the proposed amendments, the average annual LCFS credit price will also vary across the scenarios. The LCFS credit price for each scenario was estimated using the cost of obtaining the marginal, most expensive, credit in a given year.<sup>132</sup> Figure VIII-1 shows the estimated credit price for the baseline and proposed amendments scenarios from 2019 through 2030.

---

<sup>132</sup> The method used by staff to estimate the LCFS credit price for the purpose of this analysis does not assume fully rational intertemporal pricing for the LCFS credit market. Instead it shows possible market behavior under each scenario based on CARB's best estimate of LCFS market dynamics. Specifically, for the baseline scenario, the LCFS credit price trajectory includes a higher near-term credit price to reflect possible market behavior (and subsequent LCFS credit prices) during the period of steepest program target decline from 2018 through 2020, followed by a gradual settlement toward a longer-run equilibrium, that should reflect the long-run marginal cost of reducing the carbon intensity of the transportation fuel pool. These prices should be treated as illustrative rather than predictive.

**Figure VIII-1: Estimated Credit Prices for the Baseline and Proposed Amendments Scenarios**



**B. Benefits**

CARB anticipates that the proposed amendments will have the following general benefits to California businesses and individuals:

- **Reduced GHG emissions:** The LCFS is specifically designed to reduce GHG emissions in the transportation sector, which is responsible for nearly half of GHG emissions in California. This will contribute to California’s efforts to address climate change. Staff expects the proposed amendments to cumulatively reduce GHG emissions relative to the baseline by almost 70 million metric tons in carbon dioxide equivalent (MMT CO<sub>2</sub>e) from 2019 through 2030. Using the Social Cost of Carbon (SC-CO<sub>2</sub>) framework, as detailed in section B.3 of Appendix E, staff estimates that in 2030 the benefits from the proposed amendments from GHG reduction would range from approximately \$555 million to \$2.5 billion (in 2016\$).
- **Increased use of lower CI alternative fuels and alternative fueled vehicles:** The proposed amendments will increase the demand for low-CI fuels, which provides an opportunity for businesses, both in-state and out-of-state, to increase revenue from the sale of low carbon fuels in California. As shown in Table B1 of Appendix E, LCFS credits can add substantial value to low-CI fuels which include biodiesel, renewable diesel, renewable jet fuel, renewable natural gas, electricity and hydrogen. In addition to reducing GHG emissions, the increased use of alternative fuels may reduce emissions of localized air pollutants, which are the cause of many deleterious health effects on California residents. In section B.3.b-d of Appendix E, staff quantified the health benefits due to improvements in California’s air quality.
- **Increased opportunities for California businesses to invest in the production of alternative fuels and other credit generating opportunities at oil fields and**

refineries. The proposed amendments will provide long-term credit price stability relative to the baseline, which will send a signal for research and development, and deployment of innovative technologies and fuels that support California's long-term GHG emissions reduction goals. All fuel producers will have an increased incentive to innovate and deploy new methods that reduce the CI of their fuels. Additionally, the proposed amendments include a protocol that will pave the road for CCS projects, a technology area with a high potential for innovation and development.

- Reduced dependence on fossil fuel and crude oil imports and diversification of the transportation fuel pool, which may decrease the exposure of California to large swings in energy prices due to external economic shocks.

## **C. Costs**

### **1. Direct Cost Estimate**

Estimated direct costs of the proposed amendments include costs of obtaining LCFS credits and third-party verification costs. Staff expects the more aggressive CI targets in the proposed amendments to result in an increase in the costs to regulated parties of obtaining LCFS credits by: (1) increasing the total quantity of LCFS credits required to be in compliance with the rule for every gallon of high-carbon fuel sold, and (2) increasing the price of LCFS credits. The addition of third party verification will also impose a small cost on the majority of regulated parties. More details on the calculations and assumptions can be found in section C of Appendix E.

To comply with the LCFS, regulated parties must retire an equivalent number of credits to cover the deficits that they generate. To quantify the direct cost of obtaining LCFS credits, CARB uses one annual uniform LCFS credit price for all firms. Cumulatively, from 2019 through 2030, the proposed amendments are estimated to increase the total cost of obtaining LCFS credits by \$9.0 billion relative to the baseline scenario. There will also be direct costs faced by regulated entities related to the third-party verification provisions of the proposed amendments. Staff estimated third-party verification costs by surveying fuel producers, fuel importers, and potential verifiers. The addition of third party verification is expected to increase regulated parties direct costs by \$4 million by 2030.

### **2. Estimated Cost Pass-Through**

The proposed amendments will increase the costs to producers and importers of high carbon intensity fuels while producers of low carbon intensity fuels will see revenue increases. This will indirectly affect individuals in California that purchase transportation fuel, as staff assumes some portion of increased costs associated with production or import of high carbon intensity fuels will be passed on to consumers in the form of higher prices for these fuels.

The potential portion of the cost or revenue passed through to consumers can be approximated using bounding assumptions. To be conservative, staff assumed that cost increases faced by petroleum fuel producers and importers are completely passed-through to consumers. Also, revenues generated by low carbon fuels are assumed to be passed through to fuel consumers only if the credits are generated by the consumer or dispenser of the fuel.

Table VIII-1 presents a range of potential LCFS credit price pass-through for gasoline and diesel due to the proposed amendments relative to the baseline. From 2019 to 2022, the proposed amendments are projected to reduce gasoline and diesel costs, as potentially lower LCFS credit prices are estimated for these years relative to the baseline scenario. These lower credit prices result from the smoothing of the compliance target trajectory resulting in lower compliance targets, as compared to baseline, for years 2019 through 2021. From 2025 onwards, the proposed amendments are projected to potentially increase the price of gasoline by up to \$0.36 per gallon and potentially increase the price of diesel by up to \$0.44 per gallon, based on the change in estimated annual LCFS credit price and annual deficits from 2025 through 2030.

**Table VIII-1: Range of Proposed Amendments Cost Pass Through (cents/gallon)**

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gasoline	(4)-(2)	(12)-(10)	(10)-(7)	(8)-2	(4)-5	(2)-6	5-8	10-13	14-17	15-24	16-31	18-36
Diesel	(5)-(3)	(14)-(11)	(11)-(8)	(8)-3	(4)-6	(2)-7	6-10	12-15	17-20	18-28	20-37	21-44

\*Brackets indicate negative values

## D. Fiscal Impacts

### 1. State Government

Implementing the proposed amendments will affect state government finances through a change in State tax revenues, a change in the fuel expenditures for government fleets, and cost-savings from reduced health impacts.

Cumulatively over the time period from 2019 through 2030:

- State tax revenues are expected to increase by \$377 million due to higher sales taxes resulting from higher fuel prices. For more information, refer to section D.1.a of Appendix E.
- State costs for fuel purchases are estimated to increase by \$12 million due to higher fuel costs resulting from the proposed amendments. For more information, refer to section D.1.b of Appendix E.



The proposed amendments are also expected to lead to cost-savings to the California government through reduced hospital visits at state run hospitals and reduced sick days for state employees as a result of the proposed amendments. For more information, refer to section D.1.c of Appendix E.

## **2. Local Government**

Four separate impacts related to the proposed amendments affect local government finances: revenue generated from the sale of credits from transit fleets that use low-CI fuels, change in local tax revenues due to the change in the fuel mix and prices, the change in the expenditure on fuels for government fleets, and the cost-savings from reduced health impacts. See section D.2 of Appendix E for more information.

Staff conducted an analysis to project the number of credits generated by local governments, mainly through electric and natural gas fueled transit systems. Cumulatively over the time period from 2019 through 2030, local governments are expected to generate \$802 million from the sale of LCFS credits generated from the use of low-CI fuels.

Similar to changes in tax revenue for the State government, tax revenue for local governments will be affected by the proposed amendments. Cumulatively over the time period from 2019 through 2030, local governments' tax revenues are expected to increase by \$512 million due to higher sales taxes resulting from higher fuel prices.

Staff also estimated the change in fuel expenditure for local governments' fleets. Cumulatively over the time period from 2019 through 2030, staff estimates that local governments will incur an additional \$56 million due to higher fuel costs resulting from the proposed amendments.

Local governments are also expected to benefit from improvement in ambient quality through fewer employee sick days and a reduction in public hospital and emergency room visits. Local governments will also benefit from a greater ability to attain regional air quality goals.

## **E. Macroeconomic Impacts**

The proposed amendments are expected to have a broad impact on the California economy. For more details on the macroeconomic impacts of the proposed amendments, refer to section E in Appendix E.

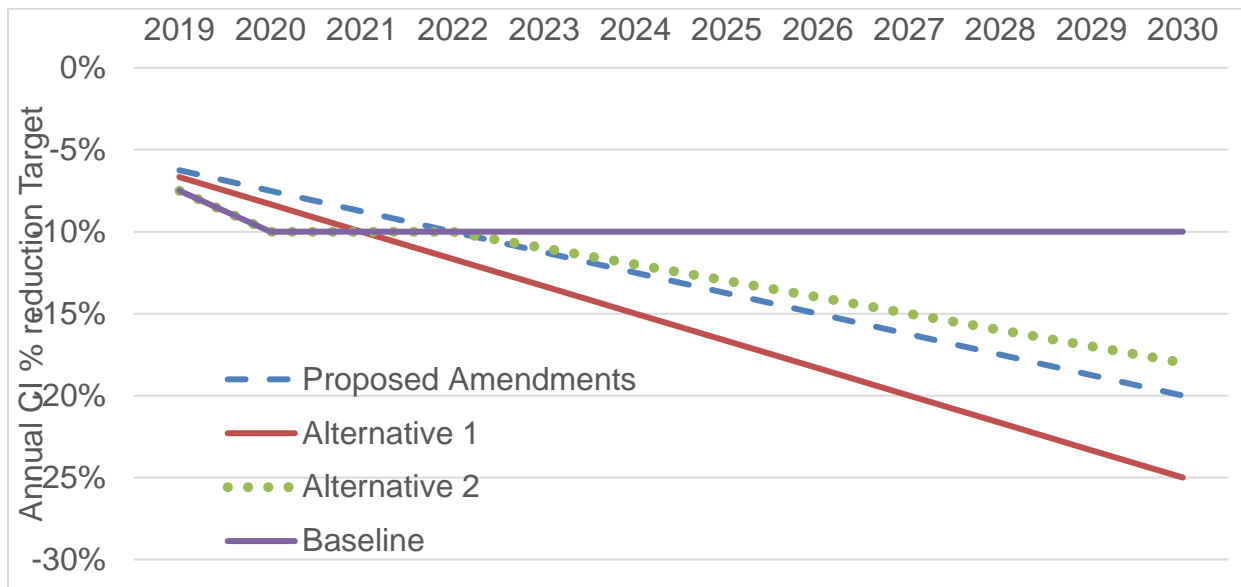
The macroeconomic analysis was performed using the Regional Economic Models, Inc. (REMI), Policy Insight Plus Version 2.1.1 to estimate the macroeconomic impacts of the proposed amendments on the California economy. REMI is a structural economic forecasting and policy analysis model that integrates input-output, computable general equilibrium, econometric and economic geography methodologies.

The REMI model results suggests that the proposed amendments will have a small positive impact on the macroeconomic indicators for the state from 2019 to 2025, followed by small negative impact on the macroeconomic indicators for the state from 2026 – 2030. Additionally, the model results show that the low carbon fuel producing sectors of the economy gain from implementing the proposed amendments at the expense of high carbon fuel producing sectors. The proposed amendments provides a larger market share for innovative alternative fuels, and shift California’s consumption towards cleaner fuels at a small cost to the California economy.

## F. Alternatives

Staff analyzed two alternatives to the proposed regulations. The first alternative is more aggressive than the proposed amendments and achieves a 25 percent CI reduction in 2030. Similar to the proposed amendments, the compliance trajectory for this alternative is smoothed by linearly reducing the benchmarks between the current 5 percent reduction in 2018 to a 25 percent reduction in 2030. The second alternative achieves an overall CI reduction target of 18 percent by 2030 but does not smooth the compliance trajectory, rather it maintains the current compliance targets through 2022 and then decreases targets linearly to an 18 percent reduction in 2030. Figure VIII-2 shows the compliance target trajectories under the 10 percent baseline scenario, the proposed amendments, and the two alternatives.

**Figure VIII-2: Proposed Compliance Targets under the Baseline Scenario, Proposed Amendments and Alternatives**



## **1. Alternative 1**

Alternative 1 includes more aggressive CI reduction targets than the proposed amendments. Under this alternative, the required annual CI reduction will be higher for all years and the State will achieve higher GHG reductions, greater supply of alternative fuels, and increased air quality benefits. These benefits, however, will be achieved at a higher cost to the California economy and California consumers, through higher gasoline and diesel prices, relative to the proposed amendments. More details on the costs, benefits, and macroeconomic impacts of this alternative can be found in section F.1 of Appendix E.

Alternative 1 achieves additional reductions of 36 MMTCO<sub>2e</sub> at an increased direct costs of \$29.5 billion above the proposed amendments. The cost effectiveness for Alternative 1, calculated as the cumulative cost of obtaining credits (relative to baseline) divided by the cumulative GHG reductions (relative to baseline), is \$364 per MT CO<sub>2e</sub> as compared to \$129 per MT CO<sub>2e</sub> for the proposed amendments.

## **2. Alternative 2**

Alternative 2 achieves an overall CI reduction target of 18 percent by 2030 but does not smooth the compliance trajectory, rather it maintains the current compliance targets through 2022 and then decreases linearly to an 18 percent reduction in 2030. Cumulatively, Alternative 2 achieves similar GHG and criteria pollutant benefits as compared to the proposed amendments. These benefits, however, will be achieved at a higher cost to the California economy and California consumers, through higher gasoline and diesel prices, relative to the proposed amendments. More details on the costs, benefits, and macroeconomic impacts of this alternative can be found in section F.2 of Appendix E.

Alternative 2 achieves the same GHG reductions as the proposed amendments but is \$3.4 billion more expensive than the proposed amendments. The cost effectiveness for Alternative 2, calculated as the cumulative cost of obtaining credits (relative to baseline) divided by the cumulative GHG reductions (relative to baseline), is \$174 per MT CO<sub>2e</sub> as compared to \$129 per MT CO<sub>2e</sub> for the proposed amendments.

## **G. Sensitivity Analysis**

Staff also conducted two sensitivity analysis that examine the impact of likely changes that will have large impacts on the LCFS program. The first analysis estimates the impact of a higher adoption rate of ZEVs relative to the proposed amendments scenario analyzed in the main revised SRIA analysis. The second analysis estimates the impacts of a higher demand for gasoline for light-duty vehicles (LDVs).

Staff finds that a higher rate of ZEV adoption will lead to similar cumulative GHG emissions reductions at a slightly reduced economic cost relative to the proposed amendments scenario. In this sensitivity analysis, staff estimates that the direct costs of

the proposed amendments will be \$4.9 billion less expensive than the main scenario. More details of this assessment can be found in section G of Appendix E.

Staff finds that a higher demand of gasoline for LDVs will lead to similar cumulative GHG emissions reductions at a higher economic cost relative to the proposed amendments scenario. In this sensitivity analysis, staff estimates that the direct costs of the proposed amendments will be \$7.8 billion more expensive than the main scenario. More details of this assessment can be found in section H of Appendix E

## **IX. EVALUATION OF REGULATORY ALTERNATIVES**

Government Code section 11346.2, subdivision (b)(4) requires CARB to consider and evaluate reasonable alternatives to the proposed regulatory action and provide reasons for rejecting those alternatives. This section discusses alternatives evaluated and provides reasons why these alternatives were not included in the proposal. As explained below, no alternative proposed was found to be less burdensome and equally effective in achieving the purposes of the regulation in a manner that ensures full compliance with the authorizing law. The Board has not identified any reasonable alternatives that would lessen any adverse impact on small business.

CARB solicited public input regarding alternatives to the proposed amendments. This solicitation was presented both in a concept paper posted on July 24, 2017<sup>133</sup> and discussed at a workshop held on August 7, 2017.<sup>134</sup> In the solicitation, staff requested that alternatives be submitted by August 21, 2017. Several stakeholders responded to the solicitation by proposing alternatives. The following summarizes alternatives suggested by stakeholders and CARB's rationale for accepting or rejecting some of the proposals.

### **A. More Aggressive CI Reduction Alternative**

NextGen California and the Natural Resources Defense Council proposed that CARB analyze an alternative that achieves a 25 percent CI reduction by 2030 as well as additional scenarios achieving between 18 and 25 percent. The American Lung Association also advocated for a LCFS target over 20 percent. Based on these comments, staff evaluated how to set a 2030 CI target that is greater than the 18 percent included in the LCFS amendments concept paper and the 2017 Climate Change Scoping Plan Update. Ultimately, staff determined a more stringent CI target of 20 percent could be established, but recognized this would be best achieved by smoothing the CI trajectory by adjusting targets for years 2019 through 2021. Staff's analysis shows that targets above 20 percent would be very difficult to achieve without substantial future growth in zero emission vehicles. Staff also included a 25 percent CI reduction scenario as one of the alternatives analyzed in the SRIA, but rejected this alternative because the cost effectiveness (\$/MTCO<sub>2e</sub>) of achieving a 25 percent CI reduction was nearly triple that of the proposed 20 percent reduction.

### **B. Western States Petroleum Association Alternative**

Western States Petroleum Association (WSPA) suggested using the Cap-and-Trade Program in lieu of LCFS to achieve equivalent GHG emissions, paired with incentives to foster innovation. That approach was not further analyzed because it is less likely to

---

<sup>133</sup> CARB, 2017. Low Carbon Fuel Standard 2018 Amendments, Pre-Rulemaking Concept Paper. [https://www.arb.ca.gov/fuels/lcfs/lcfs\\_meetings/080717conceptpaper.pdf](https://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/080717conceptpaper.pdf).

<sup>134</sup> CARB, 2017. Meeting Notice for Public Workshop to Discuss Potential Low Carbon Fuel Standard Rulemaking Items. [https://www.arb.ca.gov/fuels/lcfs/lcfs\\_meetings/080717mtgnotice.pdf](https://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/080717mtgnotice.pdf).

accomplish the innovation and fuel substituting benefits intended by the LCFS. Future emission reductions far beyond the near term reductions sought by the proposed LCFS or the Cap-and-Trade program will be necessary, and will be feasible only if transportation fuels are radically decarbonized through innovation in low carbon fuel production, distribution and use. The most effective way to achieve this is via programs that directly target transportation fuels. LCFS focuses on transportation fuels with a market approach that also minimizes the cost.

WSPA suggested that incentives, tailored to each fuel, be used in lieu of the LCFS market-based approach. This is not a feasible alternative because CARB has not been appropriated funding for such incentives. Therefore, we did not assess the performance of theoretical incentives (of unknown magnitude and funding duration) relative to that of the LCFS.

WSPA further recognized that CARB was considering a similar alternative as part of the 2030 Scoping Plan process. Extensive consideration of that alternative in this rulemaking would be redundant. In any event, the Board has and will continue to consider and compare a suite of strategies as part of the Scoping Plan process, and can steer future rulemaking efforts based on conclusions reached in that context.

### **C. Less Aggressive Reduction Alternative**

Pacific Gas and Electric (PG&E) proposed an alternative of a 15 percent CI reduction in 2030. Similarly, Chevron proposed that staff set feasible CI targets and gradually raise them as low-carbon fuels and pathways become available. Staff evaluated PG&E's proposal [to achieve only a 15 percent target] as much less beneficial in terms of greenhouse gas reductions compared to the proposed amendments. Although targeting a 15 percent reduction in CI will lower the cost of the LCFS, given the large role of transportation in California's overall emissions, staff believes this target to be insufficient. Moreover, similar to the WSPA proposal describe above, staff believes that both the PG&E and Chevron proposals are less likely to accomplish the innovation and fuel substituting benefits intended by the LCFS and that the Scoping Plan alternative scenarios offered the Board the opportunity to move in this direction if they wished to do so.

### **D. Reduced CI Target for Years 2019 and 2020 Alternative**

Renewable Products Marketing Group (RPMG) recommended a reduction to the targets over the next few years to provide a smoother transition to the new schedule while safeguarding against undue volatility. Staff reviewed and ultimately accepted this alternative by linearly reducing the proposed targets by 1.25 percent annually from a 5 percent reduction in 2018 to the 20 percent value in 2030.

#### **E. Small Business Alternative**

The proposed amendments recognize the potential cost to small businesses imposed by third-party verification, and provide more flexibility to small producers. Low carbon fuel producers that generate fewer than 6,000 credits annually are only required to verify the carbon intensity of their fuels every three years instead of annually, reducing their overall costs for verification. Currently, staff estimates that all small businesses in California that participate in the LCFS generate fewer than 6,000 credits annually. Moreover, small businesses that produce credits through lookup table hydrogen or electricity pathways will not incur third-party verification costs as CARB staff will perform verification of these hydrogen and electricity producers.

#### **F. Performance Standards in Place of Prescriptive Standards**

Government Code section 11346.2(b)(4)(A) requires that when CARB proposes a regulation that would mandate the use of specific technologies or equipment, or prescribe specific actions or procedures, it must consider performance standards as an alternative. The LCFS is a performance standard, and therefore this requirement is not applicable.

#### **G. Health and Safety Code section 57005 Major Regulation Alternatives**

CARB estimates the proposed regulation will have an economic impact on the state's business enterprises of more than \$10 million in one or more years of implementation. CARB will evaluate alternatives submitted to CARB and consider whether there is a less costly alternative or combination of alternatives that would be equally as effective in achieving increments of environmental protection in full compliance with statutory mandates within the same amount of time as the proposed regulatory requirements, as required by Health and Safety Code section 57005.

## **X. JUSTIFICATION FOR ADOPTION OF REGULATIONS DIFFERENT FROM FEDERAL REGULATIONS CONTAINED IN THE CODE OF FEDERAL REGULATIONS**

There are no current federal regulations comparable to the LCFS regulation. The U.S. Environmental Protection Agency (U.S. EPA) has adopted its Renewable Fuel Standard (RFS) regulation—title 40, Code of Federal Regulations (CFR), part 80, section 1100 et seq.—that mandates the blending of specific volumes of renewable fuels into gasoline and diesel sold in the U.S. to achieve a specified ratio for each year (i.e., the renewable fuel standard). As defined, “renewable fuels” under the RFS superficially resembles the list of transportation fuels subject to the LCFS. However, there are a number of reasons why the RFS is not comparable to the LCFS.

Congress adopted the RFS in 2005 and strengthened it in December 2007 as part of the Energy Independence and Security Act. The RFS requires that 36 billion gallons of biofuels be sold annually by 2022, of which 21 billion gallons must be “advanced” biofuels and the other 15 billion gallons can be corn ethanol. The advanced biofuels are those that achieve at least 50 percent reduction from baseline life cycle GHG emissions, with a subcategory required to meet a 60 percent reduction target. These reduction targets are based on life cycle emissions, including emissions from land use changes.

The RFS volumetric mandate alone will not achieve the objectives of the LCFS. The RFS targets only biofuels and not other alternatives; therefore, the potential value of electricity, hydrogen, and natural gas are not considered in an overall program to reduce the carbon intensity of transportation fuels. In addition, the targets of 50 percent and 60 percent GHG reductions only establish minimum requirements for biofuels, without incentivizing continuous improvements. It forces biofuels into a small number of fixed categories, without incentivizing innovations within categories. Finally, the GHG requirements do not apply to corn ethanol production plants that were existing and planned at the time of RFS adoption, thus providing no incentive for reducing the carbon intensity from these fuels.

By contrast, the LCFS regulates all transportation fuels, including biofuels and non-biofuels, with a few narrow and specific exceptions. Thus, non-biofuels such as compressed natural gas, electricity, and hydrogen may play important roles in the LCFS program. In addition, the LCFS encourages much greater innovation than the federal program by providing important incentives to continuously improve the carbon intensity of biofuel supply chains and to deploy other fuels with very low carbon intensities.

If California were to rely solely on the RFS, the State would neither achieve the fuel carbon intensity goals called for in Executive Order S-01-07, nor the 2030 GHG reduction targets of SB 32, nor stimulate the innovation needed to support future dramatic GHG reductions from the transportation sector. Because of these differences, the federal RFS regulation is complementary but not comparable to the staff’s proposal.



## Verification Amendment Discussion

The mandatory third-party LCFS verification program being proposed would help ensure the ongoing integrity of the LCFS credit market through assurance of GHG reduction claims in the LCFS. There are no current federal regulations directly comparable to the LCFS regulation. When considering programs similar to the LCFS, the U.S. EPA Renewable Fuel Standard (RFS) regulation<sup>135</sup>, 40 CFR section 80.1400 et seq., is the regulation to which those familiar with low carbon fuel standards commonly refer. U.S. EPA's RFS program and verification structure are similar to California's LCFS in some ways, and very different in other ways. Both programs require a transportation fuel volume determination and a consideration of fuel life cycle CI, resulting in LCFS credits and RFS Renewable Identification Numbers (RINs). RFS mandates the blending of specific volumes of carefully defined renewable fuels into gasoline and diesel sold in the U.S. to achieve a specified ratio for each year (i.e., the renewable fuel standard), in part to reduce GHG emissions. The RFS requires third-party attest engagements to verify RIN generation. U.S. EPA also enacted an additional, *voluntary*, third-party verification program—the Quality Assurance Plan (QAP) program—to give buyers assurance as to the quality of credits from producers who opt-in. Only a subset of RIN generators participate in this voluntary system.<sup>136</sup>

In contrast, staff proposes a *mandatory* third-party verification system for the LCFS. The LCFS regulation has unique data requirements, where each alternative transportation fuel produced and used in California has its own CI and based on the volume used in California, generates credits, which can be used to fulfill the compliance CI target which declines over time. Data types subject to verification under the proposed program include initial validation of fuel pathway applications (CIs) and ongoing verification of operation CIs and fuel quantities. The program would also include ongoing verification of petroleum data, including data reported by project applicants to calculate innovative crude and refinery credits, quantity reports to determine gasoline and diesel deficit claims, and crude oil volume reports. These data are simply not checked by the RFS QAP in many cases.

Therefore, CARB must establish a mandatory third-party verification program specific to the LCFS, while recognizing some similarities with the RFS and leveraging those areas that are appropriate. To that end, CARB staff has reached out to audit firms that provide attest engagement services and QAP services to encourage them to seek accreditation by CARB to offer LCFS verification services should this rule be approved by the Board. This will help integrate requirements in both programs for audit efficiency, while maintaining separate oversight by CARB and U.S. EPA.

---

<sup>135</sup> U.S. EPA Renewable Fuels Standard (RFS2) Final Rule, 40 CFR Part 80, section 1100 et seq.; <https://www.epa.gov/renewable-fuel-standard-program/renewable-fuel-standard-rfs2-final-rule>

<sup>136</sup> U.S. EPA Quality Assurance Plans under the Renewable Fuel Standard Program, <https://www.epa.gov/renewable-fuel-standard-program/quality-assurance-plans-under-renewable-fuel-standard-program>.

## **XI. PUBLIC PROCESS FOR DEVELOPMENT OF THE PROPOSED ACTION (PRE-REGULATORY INFORMATION)**

Consistent with Government Code sections 11346, subdivision (b), and 11346.45, subdivision (a), and with the Board's long-standing practice, CARB staff held public workshops and had other meetings with interested persons during the development of the proposed regulation. These informal pre-rulemaking discussions provided staff with useful information that was considered during development of the regulation that is now being proposed for formal public comment.

In this chapter, CARB staff provides a brief overview of the regulatory process and actions taken to develop the staff's proposed amendments and updates to the 2015 LCFS regulation.

Beginning in March 2016 and ending in November of 2017, prior to initiating the formal rulemaking process, CARB staff conducted 22 public workshops and fuel-specific working meetings, in addition to numerous private meetings and teleconferences held with individual stakeholders to discuss concepts for the proposed amendments to the LCFS regulation and address various concerns that were raised. Staff presented information that helped develop the proposed amendments and provided ample opportunities for stakeholders to provide oral and written public feedback on the concepts proposed as they took shape. Meeting attendees included transportation fuel producers, providers and importers, environmental groups, academia, verification and certification bodies, and other interested persons. These individuals participated both by reviewing written material (concept/working papers, preliminary draft regulations, and other supporting documentation), providing data, and participating in workgroup meetings.

CARB staff initially planned to conduct a rulemaking in 2017 that would have been focused on the addition of a system for third-party verification of program data and related changes to the requirements for reporting fuel transactions and fuel pathway applications. Staff would have added post-2020 carbon intensity targets in a separate rulemaking in 2019. In October 2016, staff decided to combine the two rulemakings. The passage of SB 32 and the Scoping Plan Update provided a concrete goal and initiated a process with which staff could engage to begin considering the post-2020 targets. In addition, stakeholders had expressed concerns about the amount of time needed to adjust and implement the suggested verification requirements and suggested delaying the verification rulemaking to:

- Explore opportunities for harmonization with other renewable fuel programs;
- Study implications of errors and misstatements in more depth;
- Allow entities involved in each fuel's supply chain more time to improve data systems and review contracts and agreements to support the enhanced chain of custody tracking and recordkeeping.

In response to these concerns, as well as to gain administrative efficiency, staff is undertaking a single 2018 rulemaking process (as contained in the proposed amendments).

Table XI-1 lists dates for the meetings that were held to apprise the public about the proposed amendments and other related developments.

**Table XI-1: LCFS Public Workshops and Topic-Specific Working Meetings**

Meeting	Date	Location	Time
<b>LCFS Public Workshops</b>			
2016 Public Workshop to introduce mandatory third-party pathway monitoring and verification	March 8, 2016	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.
Public Workshop to discuss proposed amendments	June 2, 2016	Cal/EPA Building, Sierra Hearing Room	9:30 a.m.
Public Workshop to discuss proposed amendments	July 29, 2016	Cal/EPA Building, Coastal Hearing Room	9:00 a.m.
Public Workshop to discuss rulemaking timeline and 2030 targets	October 24, 2016	Cal/EPA Building, Sierra Hearing Room	10:00 a.m.
Public Workshop to discuss proposed amendments and solicitation of alternative approaches	August 7, 2017	Cal/EPA Building, Sierra Hearing Room	10:00 a.m.
Public Workshop to discuss proposed amendments and draft regulatory text	September 22, 2017	Cal/EPA Building, Coastal Hearing Room	10:00 a.m.
Public Workshop to discuss proposed amendments and draft regulatory text	November 6, 2017	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.
<b>Topic-Specific Public Working Meetings</b>			
Public Working Meeting focused on Fossil and Renewable Natural Gas	December 2, 2016	Cal/EPA Building, Conference Room 550	9:00 a.m.
Public Working Meeting focused on Grid and Renewable Electricity	December 2, 2016	Cal/EPA Building, Conference Room 550	1:00 p.m.
Public Working Meeting focused on Fossil and Renewable Hydrogen	December 5, 2016	Cal/EPA Building, Sierra Hearing Room	1:00 p.m.
Public Working Meeting focused on Refinery Co-Processing	December 13, 2016	Cal/EPA Building, Conference Room 550	8:30 a.m.
Public Working Meeting focused on Verification	December 19, 2016	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.

<b>Meeting</b>	<b>Date</b>	<b>Location</b>	<b>Time</b>
Governance and Impartiality Considerations			
Public Working Meeting focused on Ethanol	January 31, 2017	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.
2 <sup>nd</sup> Public Working Meeting focused on Refinery Co-Processing	February 7, 2017	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.
Public Working Meeting focused on Biodiesel and Renewable Diesel	February 10, 2017	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.
Public Working Meeting focused on including Alternative Jet Fuel	March 17, 2017	Cal/EPA Building, Coastal Hearing Room	9:00 a.m.
Public Working Meeting focused on updates to CA-GREET and OPGEE models	April 4, 2017	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.
2 <sup>nd</sup> Public Working Meeting focused on Fossil and Renewable Natural Gas, including Biomethane from Dairy and Livestock Operations	April 17, 2017	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.
2 <sup>nd</sup> Public Working Meeting focused on Biodiesel and Renewable Diesel	May 15, 2017	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.
3 <sup>rd</sup> Public Working Meeting focused on Refinery Co-Processing	June 2, 2017	Cal/EPA Building, Sierra Hearing Room	9:00 a.m.
Public Working Meeting focused on Refinery Investment Credit Pilot Program	September 14, 2017	Cal/EPA Building, Coastal Hearing Room	9:00 a.m.
4 <sup>th</sup> Public Working Meeting focused on Refinery Co-Processing	October 16, 2017	Cal/EPA Building, Sierra Hearing Room	1:00 p.m.

Over 11,000 individuals or companies were notified for each workshop/hearing. Notices for the public meetings were posted to CARB’s LCFS public meetings web page and e-mailed to subscribers of the “LCFS,” “FUELS,” “ALLFUELS,” and “ALTDIESEL” list serves. Webcasts and teleconference options were available for each meeting to enable remote participation. In addition, CARB staff participated in numerous stakeholder meetings sponsored by other parties, presenting information on the implementation of the existing program and exploring potential amendments.

During the original 2009 rulemaking process, staff created the LCFS informational portal web site<sup>137</sup> to increase public participation and enhance the information flow between CARB staff and interested parties. Since that time, staff has consistently made available online materials related to this rulemaking, including meeting presentations, preliminary draft regulatory language, and life cycle analysis models and tools used in assessing fuel and feedstock availability to inform the proposed carbon intensity benchmarks. The web site has also provided background information on the LCFS, workshop and meeting notices and materials; other GHG related information; and links to other web sites with related information. The web site also includes feedback letters from stakeholders in response to Staff's informal workshops and working meetings that led to the proposed amendments.<sup>138</sup>

Beyond the public and workgroup meetings noted above, staff's outreach efforts also included numerous personal contacts via telephone, electronic mail, regular mail, and individual meetings with interested parties. These contacts included regulated parties, transportation fuel producers, providers, marketers, importers, environmental, community, public health organizations, and other entities.

---

<sup>137</sup> LCFS informational portal web site: <http://www.arb.ca.gov/fuels/lcfs/lcfs.htm>

<sup>138</sup> All feedback letters are posted at the following LCFS web site:  
<https://www.arb.ca.gov/fuels/lcfs/workshops/feedback.htm>

## **XII. REFERENCES**

The following documents are the technical, theoretical, or empirical studies, reports, or similar documents relied upon in proposing these regulatory amendments, identified as required by Government Code, section 11346.2, subdivision (b)(3).

Additionally, each appendix References the documents upon which it relies, as required by Government Code, section 11346.2, subdivision (b)(3).

Note: Each “Explanatory Footnote” is a footnote containing explanatory discussion rather than referencing specific documents relied upon.

## **EXECUTIVE SUMMARY**

1. Explanatory Footnote.
2. Explanatory Footnote.
3. California Governor Brown Executive Order No. B-48-18, 3 C.F.R. (2018). Office of the Governor Webpage accessed on February 24, 2018. Available at: <https://www.gov.ca.gov/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/>
4. Explanatory Footnote.
5. Explanatory Footnote.
6. Explanatory Footnote.
7. Explanatory Footnote.
8. Petroleum Market Advisory Committee, California Energy Commission, September 2017. Report: CEC-200-2017-007.
9. Transitions to Alternative Vehicles and Fuels. Committee on Transitions to Alternative Vehicles and Fuels Board on Energy and Environmental Systems Division on Engineering and Physical Sciences, National Academy of Sciences, National Research Council, (2013).
10. The upside hedge value of California’s global warming policy given uncertain future oil prices. doi 10.1016/j.enpol.2012.01.010, Fine, J., et al., Energy Policy, January 7, 2012.
11. OPEC and the Costs to the U.S. Economy of Oil Dependence: 1970-2010, The Howard H. Baker Jr. Center for Public Policy. Greene, D.L., Roderick, S.L., Hopson, J.L. (2013)
12. Costs of Oil Dependence: A 2000 Update. Greene, D.L., Tishchishyna, N.I. (2000) Oak Ridge National Laboratory.

13. Temer sanctions incentive policy for biofuels. BrazilGovNews, Federal Government of Brazil. December 28, 2017.  
Brazil to Launch Ambitious Biofuels Program. Letitia, Phillips. Ethanol Producer Magazine. November 17, 2017
14. Clean Fuel Standard Discussion Paper. Environment and Climate Change Canada. February, 2017

## **I. INTRODUCTION AND BACKGROUND**

15. California's 2017 Climate Change Scoping Plan. CARB, November 2017.
16. Explanatory Footnote.
17. Staff Report: Initial Statement of Reasons: Proposed Regulation to Implement the Low Carbon Fuel Standard. CARB, March 5, 2009.  
Staff Report: Initial Statement of Reasons: Proposed Regulation to Implement the Low Carbon Fuel Standard Volume II. CARB, March 5, 2009.  
Final Statement of Reasons for Rulemaking, Including Summary of Public Comments and Agency Responses. CARB, December 2009.
18. Staff Report: Initial Statement of Reasons: Proposed Amendments to the Low Carbon Fuel Standard. CARB, October 26, 2011.  
Final Statement of Reasons, Amendments to the Low Carbon Fuel Standard Including Summary of Public Comments and Agency Responses. CARB, October 2012.
19. Staff Report: Initial Statement of Reasons for Rulemaking: Proposed Re-adoption of the Low Carbon Fuel Standard Regulation. CARB, December 31, 2014.  
Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Response: Re-adoption of the Low Carbon Fuel Standard Regulation. CARB, October 2, 2015.
20. 2017 Progress Report on the Low Carbon Fuel Standard, California Air Resources Board Agenda Item # 17-6-4. Staff presentation available at:  
<https://www.arb.ca.gov/board/books/2017/062217/17-6-4pres.pdf>
21. Final Regulation Order, sections 95480-95497. CARB, November 2015.
22. LCFS Data Dashboard Website, Figure 11 Map. CARB webpage accessed on February 6, 2018. Available at:  
<https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>
23. LCFS Data Dashboard Website, Figure 9 LCFS Credit Market Net Position Histogram. CARB webpage, accessed on February 6, 2018. Available at:  
<https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>.

24. Weekly LCFS Credit Transfer Activity Reports. CARB webpage, accessed on February 13, 2018. Available at: <https://www.arb.ca.gov/fuels/lcfs/credit/lrtweeklycreditreports.htm>
25. 2017 Progress Report on the Low Carbon Fuel Standard, California Air Resources Board Agenda Item # 17-6-4. Staff presentation available at: <https://www.arb.ca.gov/board/books/2017/062217/17-6-4pres.pdf>
26. Final Regulation Order, sections 95496(b). CARB, November 2015. Available at: <https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf>
27. California Greenhouse Gas Emission Inventory - 2017 Edition CARB Webpage, accessed on February 23, 2018. Available at: <https://www.arb.ca.gov/cc/inventory/data/data.htm>

## **II. THE PROBLEM THAT THE PROGRAM IS INTENDED TO ADDRESS**

28. Explanatory Footnote.
29. Aircraft Engine Emissions International Civil Aviation Organization (ICAO) Webpage, accessed on February 20, 2018. Available at: <https://www.icao.int/environmental-protection/Pages/aircraft-engine-emissions.aspx>
30. Factors that have Enabled Success Presentation on Alternative Jet Fuels: Slides 3-5. ICAO Seminar on Alternative Fuels, February 8 and 9, 2017.
31. Alternative Fuels Test on a C-17 Aircraft: Emissions Characteristics. Fuels and Energy Branch Energy/Power/Thermal Division. Corporan, Edwin. December 2010.
32. California Senate Bill 1505, Lowenthal, 2006.
33. California Transportation Data for Alternative Fuels and Vehicles. U.S DOE Alternative Fuels Data Center Webpage, accessed December 26, 2017. Available at: <https://www.afdc.energy.gov/states/ca>.
34. Alternative Fuel Guidelines for Alternative Transportation Systems. John A. Volpe National Transportation Systems Center. January 2011.
35. Propane Vehicle Emissions. U.S. DOE Alternative Fuels Data Center Webpage, accessed February 7, 2018. Available at: [https://www.afdc.energy.gov/vehicles/propane\\_emissions.html](https://www.afdc.energy.gov/vehicles/propane_emissions.html)
36. Public Workshop on Fiscal Year 2017-18 Funding Plan for Clean Transportation Incentives 2017. CARB. Notice released date: September 26, 2017.
37. Coprocessing of Catalytic-Pyrolysis-Derived Bio-Oil with VGO in a Pilot-Scale FCC Riser. Industrial & Engineering Chemistry Research 2016 55 (12), 3525-3534 DOI: 10.1021/acs.iecr.5b03008, Wang, C.; Li, M.; Fang, Y. March 3, 2016
38. California Sustainable Freight Action Plan. Office of the Governor Edmund G. Brown Jr. July 2016.



39. Mandatory GHG Reporting – Verification. CARB Webpage, accessed on February 4, 2018, available at: <https://www.arb.ca.gov/cc/reporting/ghg-ver/ghg-ver.htm>.
40. Offset Verification Program. CARB Webpage, accessed on October 25, 2017. Available at: <https://www.arb.ca.gov/cc/capandtrade/offsets/verification/verification.htm>
41. Staff White Paper Framework for Development of a Low Carbon Fuel Standard Verification Program. CARB, October 21, 2016.

### **III. THE SPECIFIC PURPOSE OF EACH ADOPTION, AMENDMENT, OR REPEAL & THE RATIONALE FOR ARB'S DETERMINATION THAT EACH IS REASONABLY NECESSARY**

42. Aviation Gasoline definition. U.S. EPA Webpage, accessed on October 30, 2017. Available at: <https://www3.epa.gov/ghgreporting/help/tool2014/definitions/aviation-gasoline.html>.
43. Standard Specification for Aviation Turbine Fuels ASTM Specification D1655-17.
44. Low Carbon Fuel Standard User Guide Version 1.0 LCFS Reporting Tool (LRT) Credit Bank and Transfer System (CBST). CARB, April 26, 2016.
45. Green Tariff/Shared Renewables Program (GTSR), California Public Utilities Commission, webpage, accessed on February 17, 2018. Available at: <http://www.cpuc.ca.gov/General.aspx?id=12181>
46. Aircraft Engine Emissions International Civil Aviation Organization (ICAO) Webpage, accessed on September 22, 2017. Available at: <https://www.icao.int/environmental-protection/Pages/aircraft-engine-emissions.aspx>,
47. California Senate Bill 1505, Lowenthal, 2006.
48. Explanatory Footnote.
49. Explanatory Footnote.
50. California Sustainable Freight Action Plan. Office of the Governor Edmund G. Brown Jr., July 2016.
51. Full Fuel Cycle Assessment: Tank to Wheels Emissions and Energy Consumption, CEC-600-2007-003-D. California Energy Commission, February 2007.
52. Calculation of Proposed Energy Economy Ratio under the Low Carbon Fuel Standard Regulation. CARB, November 2014.
53. Battery Electric Truck and Bus Energy Efficiency Compared to Conventional Diesel Vehicles. CARB, September 2017.

54. Calculation of Proposed Energy Economy Ratio (EER) for Electric Transport Refrigeration Units (eTRU) under the Low Carbon Fuel Standard. CARB, September 2017.
55. Estimate for Energy Economy Ratios for Consideration of On-Road and Off-Road Motorcycles in the Low Carbon Fuels Standard Program. CARB, October 9, 2017.
56. eGRID2014 Version 2, U.S. EPA, accessed on December 13, 2017. Available at: <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>
57. Data Provided by UNICA on July 13, 2017, via email by Lais Thomas of UNICA, office in Washington D.C
58. Table 127-0007. Electric power generation, by class of electricity producer, annual (megawatt hour). Statistics Canada Webpage, accessed on January 12, 2018.
59. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. IPCC, 2014.
60. California's Energy Future: The View to 2050 California Council on Science and Technology. CCST, May 2011.
61. California Senate Bill No. 32. Pavley 2016.
62. California Governor Brown Executive Order No. B-30-15 (2015), and California Governor Schwarzenegger Executive Order S-03-05 (2005).
63. Program Manual, Climate Action Reserve Verification. September 1, 2015.
64. The Climate Registry General Verification Protocol for the Voluntary Reporting Program Version 2.0, June 2010.

#### **IV. BENEFITS OF THE PROPOSED AMENDMENTS**

65. Explanatory Footnote.
66. Explanatory Footnote.
67. IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, H. C. de Coninck, M. Loos, and L. A. Meyer (eds.)]. IPCC, 2005.
68. Policies for California's Energy Future - Electricity from Natural Gas with CO<sub>2</sub> Capture for Enhanced Oil Recovery, Emission accounting under Cap-&-Trade and LCFS. CCST Publications. January 2015.
69. Low Carbon Fuel Standard: Evaluation of jet fuel inclusion Presentation at public working meeting. CARB, March 17, 2017.
70. Explanatory Footnote.

## V. AIR QUALITY

71. California's Oil Refineries, California Energy Commission Webpage, accessed on February 6, 2018. Available at: [http://energy.ca.gov/almanac/petroleum\\_data/refineries.html](http://energy.ca.gov/almanac/petroleum_data/refineries.html)
72. CEPAM: 2016 SIP - Standard Emission Tool, Emission Projections by Summary Category Base Year: 2012 CARB Webpage, accessed on November 22, 2017. Available at: <https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>
73. Facility Search Engine. CARB Webpage, accessed on February 6, 2018. Available at: <https://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php?dd>
74. Ibid.
75. CEPAM: 2016 SIP - Standard Emission Tool, Emission Projections By Summary Category Base Year: 2012. CARB webpage, accessed on November 22, 2017. Available at: <https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>
76. Area Designations (Activities and Maps). CARB Webpage, accessed February 17, 2018. Available at: <https://www.arb.ca.gov/desig/changes.htm>.
77. Area Designations for State Ambient Air Quality Standards - Ozone. June 2017. CARB. Available at: [https://www.arb.ca.gov/desig/adm/2016/state\\_o3.pdf](https://www.arb.ca.gov/desig/adm/2016/state_o3.pdf)
78. Chronology of State PM2.5 Designations. Updated June 7, 2017. CARB. Available at: <https://www.arb.ca.gov/desig/changes/pm25.pdf> .
79. Chronology of State PM10 Designations. Updated June 7, 2017. CARB. Available at: <https://www.arb.ca.gov/desig/changes/pm10.pdf>
80. Evaluation of Bio-Derived Synthetic Paraffinic Kerosenes (Bio2SPK), Research Report D02-1739. Committee D02 on Petroleum Products and Lubricants, Subcommittee D02.J0.06 on Emerging Turbine Fuels, ASTM International, West Conshohocken, PA, June 28, 2011. Boeing Company, UOP, U.S. Air Force Research Laboratory, 2011.
81. Evaluation of Synthesized Iso-Paraffins Produced from Hydroprocessed Fermented Sugars (SIP Fuels), Final Version (3.1). Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants, Subcommittee D02.J0 on Aviation Fuels, Research Report D02-1776, ASTM International, West Conshohocken, PA, June 15, 2014. Rolland, O. and Garcia, F., 2014. TOTAL New Energies, Amyris, Inc., U.S. Air Force Research Laboratory, 2014

82. Evaluation of Alcohol to Jet Synthetic Paraffinic Kerosenes (ATJ-SPKs), Report Version (1.10). Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants, Subcommittee D02.J0 on Aviation Fuels, Research Report D02-1828, ASTM International, West Conshohocken, PA, 1 Edwards, T., Meyer, D., Johnston, G., McCall, M., Rumizen, M., and Wright, M., April 2016.
83. Alternative Fuels Tests on a C-17 Aircraft: Emissions Characteristics, Air Force Research Laboratory, Interim Report, AFRL-RZ-WP-TR-2011-2004, Corporan, E., DeWitt, M.J., Klingshirn, C.D., Anneken, D., Wright-Patterson Air Force Base, OH, December 2010.
84. Energy and Environmental Viability of Select Alternative Jet Fuel Pathways, 47th AIAA/ASME, SAE, ASEE Joint Propulsion Conference & Exhibit, San Diego, CA, AIAA 201115968, July 31 – August 3, 2011. Carter, Nicholas A., Stratton, R.W., Bredehoeft, M.K., and Hileman, 2011. J.I.
85. Impact of Alternative Fuels on Emissions Characteristics of a Gas Turbine Engine – Part 1: Gaseous and Particulate Matter Emissions. Environmental Science & Technology 2012 46 (19), 10805-10811. DOI: 10.1021/es301898u Lobo et al., 2012.
86. Air Quality Guidance for Siting Biorefineries in California. CARB, Stationary Source Division, Adopted in November 2011.
87. Air pollution impacts from carbon capture and storage (CCS). EEA Technical report No 14/2011. European Environmental Agency (2011).
88. Explanatory Footnote.
89. Explanatory Footnote.
90. Evaluation of Bio-Derived Synthetic Paraffinic Kerosenes (BioSPKs). Committee D02 on Petroleum Products and Lubricants, Subcommittee D02.J0.06 on Emerging Turbine Fuels, Research Report D02-1739, ASTM International, West Conshohocken, PA. Boeing Company, UOP, U.S. Air Force Research Laboratory, June 28, 2011.
91. Evaluation of Alcohol to Jet Synthetic Paraffinic Kerosenes (ATJ-SPKs), Report Version (1.10). Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants, Subcommittee D02.J0 on Aviation Fuels, Research Report D02 1828, ASTM International, West Conshohocken, PA, 1. Edwards, Tim, Meyer, D., Johnston, G., McCall, M., Rumizen, M., Wright, M. April 2016.
92. Chemical, Thermal Stability, Seal Swell, and Emissions Studies of Alternative Jet Fuels. Energy & Fuels, 25, 955-966. Corporan, Edwin, Edwards, T., Shafer, L., DeWitt, M.J., Klingshirn, C.D., Zabarnick, S., West, Z., Striebich, R., Graham, J., Klein, J. 2011.
93. Explanatory Footnote.
94. Intake fraction of primary pollutants: motor vehicle emissions in the South Coast Air Basin. Atmospheric Environment 37 (2003) 3455–3468. Marshall, J.D., et al. 2003.
95. Explanatory Footnote.

96. Explanatory Footnote.
97. Explanatory Footnote.
98. Quantitative Health Risk Assessment for Particulate Matter (Final Report). EPA-452/R-10-005, June 2010.
99. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F. U.S. EPA. Final Report, December 2009.
100. Ibid.
101. Estimate of Premature Deaths Associated with Fine Particle Pollution (PM<sub>2.5</sub>) in California Using a U.S. Environmental Protection Agency Methodology. CARB, 2010.
102. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F. U.S. EPA, December 2009.
103. Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. Health Effects Institute Research Report 140. Krewski et al. May 2009.
104. The Burden of Air Pollution: Impacts Among Racial Minorities. Environmental Health Perspectives; 109 (4):501–506. Gwynn, RC and Thurston, GD., (2001).
105. Proposed Regulatory Amendments to the Heavy-Duty Vehicle Inspection Program and Periodic Smoke Inspection Program Standardized Regulatory Impact Assessment (SRIA). CARB, August 10, 2017
106. Explanatory Footnote.
107. Air Toxics Hot Spots Program Risk Assessment Guidelines. Office of Environmental Health Hazard Assessment. February 2015.
108. Staff Report: Initial Statement of Reasons for Rulemaking: Proposed Re-adoption of the Low Carbon Fuel Standard Regulation. CARB, December 31, 2014.

## **VI. ENVIRONMENTAL ANALYSIS**

No references.

## **VII. ENVIRONMENTAL JUSTICE**

109. Priority EJAC Recommendations and CARB Response. CARB, May 23, 2017.

110. AB 32 Environmental Justice Advisory Committee (EJAC) Recommendations, California Air Resources Board – 2017 Scoping Plan Appendix A. CARB, November 2017.
111. Environmental Justice Advisory Committee. CARB Webpage, accessed on February 17, 2018. Available at: <https://www.arb.ca.gov/cc/ejac/ejac.htm>
112. SB 115 (Solis, Stats. 1999, ch. 690), which added Government Code, section 65040.12, subdivision (c).
113. Policies and Actions for Environmental Justice. CARB, December 13, 2001.
114. First Update to the Climate Change Scoping Plan. CARB, May 2014.
115. California’s 2017 Climate Change Scoping Plan. CARB, November 2017.
116. California Code, Health & Safety Code-HSC sec. 38560.5., FindLaw Webpage, accessed on February 17, 2018. Available at: <http://codes.findlaw.com/ca/health-and-safety-code/hsc-sect-38560-5.html>
117. Air Quality Guidance for Siting Biorefineries in California. CARB, Stationary Source Division, November 2011.  
 Letter to Mary Nichols from EJAC Co-Chairs. Dated April 21, 2009.  
 Board Resolution 09-31, Agenda Item No. 09-4-4. April 29, 2009.
118. Appendix A, Final Recommendations of Environmental Justice Advisory Committee on the Proposed AB 32 Scoping Plan. EJAC, April 11, 2014.
119. LCFS Crude Oil Lifecycle Assessment. CARB Webpage, accessed on February 17, 2018. Available at: <https://www.arb.ca.gov/fuels/lcfs/crude-oil/crude-oil.htm>
120. Oil and Gas Regulation. CARB Rulemaking Website, accessed on February 17, 2018. Available at: <https://www.arb.ca.gov/regact/2016/oilandgas2016/oilandgas2016.htm>
121. World Cafe Method the World Cafe. Webpage, accessed on February 17, 2018. Available at: <http://www.theworldcafe.com/key-concepts-resources/world-cafe-method/>
122. AB 32 Environmental Justice Advisory Committee (EJAC) Recommendations, California Air Resources Board – 2017 Scoping Plan- Appendix A. November 2017.
123. AB 32 Environmental Justice Advisory Committee (EJAC) Recommendations for Proposed 2030 Target Scoping Plan Update Scoping Plan. EJAC, December 22, 2016.
124. LCFS Data Dashboard Website, Figure 11 Map. CARB Webpage, accessed on February 6, 2018. Available at: <https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>
125. By The Numbers – FCEV Sales, FCEB, & Hydrogen Station Data. California Fuel Cell Partnership Webpage, accessed on February 17, 2018. Available at: [https://cafcp.org/by\\_the\\_numbers](https://cafcp.org/by_the_numbers)

126. AB 32 Environmental Justice Advisory Committee (EJAC) Recommendations for Proposed 2017 Scoping Plan Update, December 22, 2016.
127. CalEnviroScreen 3.0 Results. OEHHA Mapping Website, accessed February 6, 2018. Available at: <https://oehha.ca.gov/calenviroscreen/sb535>
128. Explanatory Footnote.
129. Multimedia Evaluation of Biodiesel and Renewable Diesel Presentation, Public Meeting of the California Environmental Policy Council. June 23, 2015.
130. Reducing Short-Lived Climate Pollutants in California. CARB webpage, accessed on February 6, 2018. Available at: <https://www.arb.ca.gov/cc/shortlived/shortlived.htm>
131. Ibid.

## **VIII. ECONOMIC IMPACTS ANALYSIS**

132. Explanatory Footnote.

## **IX. EVALUATION OF REGULATORY ALTERNATIVES**

133. Low Carbon Fuel Standard 2018 Amendments, Pre-Rulemaking Concept Paper. CARB, July 24, 2017.
134. Meeting Notice for Public Workshop to Discuss Potential Low Carbon Fuel Standard Rulemaking Items. CARB, July 24, 2017.

## **X. JUSTIFICATION FOR ADOPTION OF REGULATIONS DIFFERENT FROM FEDERAL REGULATIONS CONTAINED IN THE CODE OF FEDERAL REGULATIONS**

135. Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Final Rule, 40 CFR Part 80, section 1100 et seq.; U.S. EPA, March 26, 2010.
136. Quality Assurance Plans under the Renewable Fuel Standard Program. U.S. EPA Webpage, last updated August 16, 2016.

## **XI. PUBLIC PROCESS FOR DEVELOPMENT OF THE PROPOSED ACTION (PRE-REGULATORY INFORMATION)**

137. Low Carbon Fuel Standard. CARB Informational Website, last reviewed on December 13, 2017. Available at: <http://www.arb.ca.gov/fuels/lcfs/lcfs.htm>
138. Stakeholder Letters in response to LCFS Workshops. CARB Webpage, last reviewed on January 26, 2018. Available at: <https://www.arb.ca.gov/fuels/lcfs/workshops/feedback.htm>



## **Appendix B      Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard**

1. EPA Underground Injection Control Program, 40 C.F.R. §144 (2014).
2. EPA Underground Injection Control Program, 40 C.F.R. §144, §145, and §146 (2014).
3. Business and Innovation within the Victorian State Government (Australia) Energy and Earth Resources, Department of State Development, Breaking Energy Website, accessed February 7, 2018. Available at: <https://breakingenergy.com/2014/06/13/infographic-carbon-capture-and-storage-ccs/>
4. Final Regulation Order, Amendments to the Regulation, Mandatory Reporting of Greenhouse Gas Emissions Regulation. CARB, filed with Secretary of State September 1, 2017.
5. Experimental evaluation of interactions in supercritical CO<sub>2</sub>/water/rock minerals system under geologic CO<sub>2</sub> sequestration conditions. Lin, H., Takashi, F., Reisque, T., Takahashi, T., and Hashida, T. Journal of Materials Science, v. 43, n. 7, p. 2307–2315. (2008).
6. Recommendations for Geologic Carbon Sequestration in California: I. Siting Criteria and Monitoring Approaches, II. Example Application Case Study, Energy Geosciences Division, Lawrence Berkeley National Laboratory. C., Oldenburg, P.D., Jordan, and E., Burton, (2017).
7. Pre-Rulemaking Discussion Draft 04-26-17 Updated Underground Injection Control Regulations, California Code of Regulations, Title 14, § 1724.14, (2017).
8. Standard Guide for Soil and Gas Monitoring in the Vadose Zone, ASTM D5314 - 092 ASTM International (ASTM) (2001). <http://www.astm.org>
9. Groundwater Section Guidance Number 39, Denver, CO. U.S. EPA Region 8. (1995; updated 2006)
10. Design, Installation, Operation, Test, and Redress of Subsurface Safety Valve Systems, 6. API Recommended Practice 14B (2005)
11. Unofficial electronic version of Regulation for the Mandatory Reporting of Greenhouse Gas Emissions. CARB, February 2014.
12. Direct Emissions from Stationary Combustion Sources. U.S. EPA Center for Corporate Climate Leadership – GHG Inventory Guidance, January 2016.
13. Methodology for Greenhouse Gas Emission Reductions from Carbon Capture and Storage Projects, Version 1. The American Carbon Registry (2015). Available at <http://americancarbonregistry.org/carbon-accounting/standards-methodologies/carbon-capture-and-storage-in-oil-and-gas-reservoirs/acr-ccs-methodology-v1-0-final.pdf>

14. Evaluating the climate benefits of CO<sub>2</sub>-enhanced oil recovery using life cycle analysis. *Environmental science & technology* 49.12 7491-7500. Cooney, Gregory, et al. (2015).
15. U.S. Department of Energy's Site Screening, Site Selection, and Initial Characterization for Storage of CO<sub>2</sub> in Deep Geological Formations, *Energy Procedia*, v. 4, p. 4664–4671. T. Rodosta, J. Litynski, S. Plasynski, S. Hickman, S. Frailey, and L. Myer, (2011).
16. CCS Site Characterisation Criteria, 2009/10, International Energy Agency Greenhouse Gas R&D Programme (IEA GHG), July 2009.
17. BEST PRACTICES: Site Screening, Selection, and Initial Characterization for Storage of CO<sub>2</sub> in Deep Geologic Formations, DOE/NETL-2017/1844. National Energy Technology Laboratory (DOE/NETL), 2017.
18. Storage Capacity Estimation, Site Selection and Characterisation for CO<sub>2</sub> Storage Projects, Cooperative Research Centre for Greenhouse Gas Technologies, Canberra, CO<sub>2</sub>CRC Report No. RPT08-1001, 52pp. CO<sub>2</sub>CRC, 2008.
19. A preliminary feasibility study for the underground disposal of Carbon Dioxide in UK, British Geological Survey, National Environmental Research Council, Fluid Processes Research Group Technical Report WE/91/20/C, 28 pp. D. Holliday, G. Williams, S. Holloway, D. Savage, and M. Bannon, 1991.
20. Experimental evaluation of interactions in supercritical CO<sub>2</sub>/water/rock minerals system under geologic CO<sub>2</sub> sequestration conditions. Lin, H., Takashi, F., Reisque, T., Takahashi, T., and Hashida, T (2008) *Journal of Materials Science*, v. 43, n. 7, p. 2307–2315.
21. Recommendations for Geologic Carbon Sequestration in California: I Siting Criteria and Monitoring Approaches, II. Example Application Case Study, Report LBNL-1007267, June 2017, 154 pp. C. Oldenburg, P. Jordan, and E. Burton, 2017.
22. Explanatory Footnote.
23. Sequestration of CO<sub>2</sub> in geological media: roadmap for site selection using the transform or the geological space into the CO<sub>2</sub> phase space, *Energy Conversion and Management*, v. 41, p. 53–70. S. Bachu, 2002.
24. Aquifer Disposal of Carbon Dioxide: An Examination, Center for Groundwater Studies, CSIRO Land and Water, Parliamentary Inquiry into the Regulatory Arrangements for Trading in Greenhouse Gas Emissions, Technical Report 36/98, 17 pp. C. Otto, 1998.
25. Explanatory Footnote.
26. TOUGH Manuals, Lawrence Berkeley National Laboratory Website, accessed on February 22, 2018. Available at: <http://esd1.lbl.gov/research/projects/tough/documentation/manuals.html>

27. BEST PRACTICES: Risk Management and Simulation for Geologic Storage Projects, DOE/NETL-2017/1846. National Energy Technology Laboratory (DOE/NETL), 2017.
28. BEST PRACTICES: Monitoring, Verification, and Accounting (MVA) for Geologic Storage Projects, DOE/NETL-2017/1847. National Energy Technology Laboratory (DOE/NETL), 2017.
29. Best Practices for Carbon Storage Systems and Well Management Activities, DOE/NETL-2013/1604. National Energy Technology Laboratory (DOE/NETL), Revised, 2013.
30. Land Use, Land-Use Change and Forestry. IPCC Webpage, accessed on February 17, 2018. Available at: [http://www.ipcc.ch/ipccreports/sres/land\\_use/index.php?idp=74](http://www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=74)
31. Explanatory Footnote.
32. IPCC Special Report on Carbon dioxide Capture and Storage, Chapter 9; Implications of carbon dioxide capture and storage for greenhouse gas inventories and accounting. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [Metz, B., O. Davidson, H. C. de Coninck, M. Loos, and L. A. Meyer (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 442 pp.
33. Explanatory Footnote.
34. Explanatory Footnote.
35. Best Practices: Risk Management and Simulation for Geologic Storage Projects, DOE/NETL-2017/1846. National Energy Technology Laboratory (DOE/NETL), 2017.
36. Geologic Sequestration of Carbon Dioxide: Underground Injection Control (UIC) Program Class VI Financial Responsibility Guidance. U.S. EPA, July 2011.
37. The cost of CO<sub>2</sub> capture and storage. International Journal of Greenhouse Gas Control 40: 378–400. Rubin, E. S., J. E. Davison, et al. (2015).
38. IPCC Special Report on Carbon Dioxide Capture and Storage. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [B. Metz, O. Davidson, H. de Coninck, M. Loos, and L. Mayer (eds.)]. IPCC, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 442 pp. IPCC, 2005,

## Appendix C CA-GREET3.0 Technical Support Documentation

1. Explanatory Footnote.
2. Explanatory Footnote.
3. Explanatory Footnote.
4. Cellunator® Edeniq Products. Webpage, accessed on February 7, 2018. Available at <https://www.edeniq.com/products/>
5. Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Model Version 2.0b. El-Houjeiri, H.M., Vafi, K., Masnadi, M.S., Duffy, J., McNally, S., Sleep, S., Pacheco, D., Dashnadi, Z., Orellana, O., MacLean, H., Englander, J., Bergerson, J and A.R. Brandt. November 30, 2017.
6. 2014 Edition of California’s 2000-2012 Greenhouse Gas Emissions Inventory Technical Support Document. California Environmental Protection Agency, CARB, May 2014.
7. EMFAC2011 and EMFAC2014. CARB Website, accessed on December 13, 2017. Available at: <http://www.arb.ca.gov/msei/categories.htm>
8. Detailed California-Modified GREET Pathway for Ultra Low Sulfur Diesel (ULSD) from Average Crude Refined in California Version 2.1. CARB, February 28, 2009.
9. Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance: Direct Emissions from Mobile Combustion Sources. U.S. EPA, EPA430-K-08-004, May 2008.
10. Emissions of nitrous oxide and methane from conventional and alternative fuel motor vehicles. Lipman, Timothy E., and Mark A. Delucchi. Climatic Change 53, no. 4 (2002): 477-516.
11. Argonne provides two references for the alternative fuel vehicle fuel economy scale factors in GREET:  
  
Norman Brinkman, Michael Wang, Trudy Weber, Thomas Darlington. Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems— A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions, May 2005.  
  
A. Elgowainy, J. Han, L. Poch, M. Wang, A. Vyas, M. Mahalik, A. Rousseau. Well-to-Wheels Analysis of Energy Use and Greenhouse Gas Emissions of Plug-In Hybrid Electric Vehicles, June 1, 2010.
12. The GREET Model Expansion for Well-to-Wheels Analysis of Heavy-Duty Vehicles Argonne National Laboratory, October 2015.

13. Renewable & Alternative Fuels, Alternative Fuel Vehicle Data. U.S. Energy Information Administration Website, accessed on December 13, 2017. Available at <http://www.eia.gov/renewable/afv/users.cfm>.  
See also vehicle category Definitions:  
[http://www.eia.gov/renewable/alternative\\_transport\\_vehicles/pdf/defs-sources-notes.pdf](http://www.eia.gov/renewable/alternative_transport_vehicles/pdf/defs-sources-notes.pdf)
14. Personal email communication with EIA AFV User Database Collection Manager. May 15, 2015.
15. eGRID 9th edition Version 2.0. U.S. EPA Website, accessed on December 13, 2017. Available at: <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>
16. 2016 California Total System Electric Generation data. California Energy Commission (CEC) Website, accessed on January 3, 2018. Available at: [http://www.energy.ca.gov/almanac/electricity\\_data/total\\_system\\_power.html](http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html)
17. The Empresa de Pesquisa Energética data was provided by UNICA on July 13, 2017 via email by Lais Thosmas of UNICA, office in Washington D.C.
18. Table 127-0006; Electricity generated from fuels, by electric utility thermal plants, CANSIM (database). Statistics Canada Webpage, accessed on January 12, 2018. Available at: <http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1270006&tabMode=dataTable&p1=-1&p2=9&srchLan=-1>  
Table 127-0007; Electric power generation, by class of electricity producer, CANSIM (database). Statistics Canada Webpage, accessed on January 12, 2018. Available at: <http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1270007&tabMode=dataTable&srchLan=-1&p1=-1&p2=9>
19. N2O emissions from managed soils, and CO2 emissions from lime and urea application 2006 IPCC Guidelines for National Greenhouse Gas Inventories vol 4 (Hayama: IGES) chapter 11 IPCC (2006)
20. Summary of Expansions, Updates, and Results in GREET® 2016 Suite of Models. Systems Assessment Group, Energy Systems Division, Argonne National Laboratory. ANL/ESD-16/21. Available at: <https://greet.es.anl.gov/files/summary-updates-2016>
21. Energy and greenhouse gas emission effects of corn and cellulosic ethanol with technology improvements and land use changes. Biomass and Bioenergy 35, no. 5. Wang, Michael Q., Jeongwoo Han, Zia Haq, Wallace E. Tyner, May Wu, and Amgad Elgowainy. (2011).
22. 2012 Corn Ethanol: Emerging Plant Energy and Environmental Technologies, UIC Energy Resources Center, Mueller, Steffen and Kwik, John, (2013).

23. Estimated displaced products and ratios of distillers' co-products from corn ethanol plants and the implications of lifecycle analysis. ): 911-922, *Biofuels* 1, no. 6 Arora, Salil, May Wu, and Michael Wang. (2010).
24. CA-GREET2.0 Supplemental Document and Tables of Changes, CARB, June 4, 2015.
25. N<sub>2</sub>O emissions from managed soils, and CO<sub>2</sub> emissions from lime and urea application 2006 IPCC Guidelines for National Greenhouse Gas Inventories vol 4 (Hayama: IGES) chapter 11 IPCC (2006)
26. IPCC Expert Meeting on HWP, Wetlands and Soil N<sub>2</sub>O IPCC 2010 (Geneva, October 2010)
27. Methane and nitrous oxide emissions affect the life-cycle analysis of algal biofuels. *Environmental Research Letters* 7, no. 1 Frank, Edward D., Jeongwoo Han, Ignasi Palou-Rivera, Amgad Elgowainy, and Michael Q. Wang. (2012): 014030.
28. Explanatory Footnote.
29. Life cycle assessment of Brazilian sugarcane products: GHG emissions and energy use. *Biofuels, Bioproducts and Biorefining* 5, no. 5 Seabra, Joaquim EA, Isaias C. Macedo, Helena L. Chum, Carlos E. Faroni, and Celso A. Sarto. (2011): 519-532.
30. Molasses for ethanol: the economic and environmental impacts of a new pathway for the lifecycle greenhouse gas analysis of sugarcane ethanol. *Environmental Research Letters* 4, no. 4 Gopal, Anand R. and Daniel M. Kammen. (2009): 044005.
31. Direct and Indirect Greenhouse Gas Emissions from Biomass Storage: Implications for Life Cycle Assessment of Biofuels. Order No. 3612988, Purdue University, Emery, Isaac R., December 2013.
32. Modeling state-level soil carbon emission factors under various scenarios for direct land use change associated with United States biofuel feedstock production. *Biomass and Bioenergy* 55 Kwon, Ho-Young, Steffen Mueller, Jennifer B. Dunn, and Michelle M. Wander., (2013): 299-310.
33. The impact of dry matter loss during herbaceous biomass storage on net greenhouse gas emissions from biofuels production. *biomass and bioenergy* 39 Emery, Isaac R., and Nathan S. Mosier. (2012): 237-246.
34. Material and Energy Flows in the Production of Cellulosic Feedstocks for Biofuels in the GREET Model, Argonne National Laboratory, Zhichao Wang, Jennifer B. Dunn, Jeongwoo Han, and Michael Wang, 2013.
35. Achievement of Ethanol Cost Targets: Biochemical Ethanol Fermentation via Dilute-Acid Pretreatment and Enzymatic Hydrolysis of Corn Stover. No. NREL/TP-5100-61563. National Renewable Energy Laboratory (NREL), Golden, CO., 2014. Tao, L., D. Schell, R. Davis, E. Tan, R. Elander, and A. Bratis. NREL 2012

36. Process design and economics for biochemical conversion of lignocellulosic biomass to ethanol. National Renewable Energy Laboratory Technical Report NREL. TP-5100-47764, Humbird, D., R. Davis, L. Tao, C. Kinchin, D. Hsu, A. Aden, P. Schoen et al. 2011.
37. National Sorghum Producers Carbon Intensity Calculations Based on 2015 SGS North America Report and Supporting Documentation. March 30, 2017
38. Cellunator® Edeniq Products Webpage, accessed on February 7, 2018. Available at <https://www.edeniq.com/products/>
39. U.S EPA guideline for corn fiber ethanol to generate D3 RINs: 40 CFR Ch. I (7–1–11 Edition)
40. Explanatory Footnote.
41. Explanatory Footnote.
42. Life Cycle Impact of Soybean Production and Soy Industrial Products. Prepared for the United Soybean Board. Omni Tech International, 2010. Available at: [http://biodiesel.org/reports/20100201\\_gen-422.pdf](http://biodiesel.org/reports/20100201_gen-422.pdf)
43. Life cycle energy and greenhouse gas emission effects of biodiesel in the United States with induced land use change impacts. *Bioresource Technology*. 251:249-258. Chen, R., Qin, Z., Han, J., Wang, M., Taheripour, F., Tyner, W., O'Connor, D., Duffield, J. 2018. Available at: <https://doi.org/10.1016/j.biortech.2017.12.031>
44. Life Cycle Impact of Soybean Production and Soy Industrial Products, Industry Publication, The United Soybean Board (2010).
45. Explanatory Footnote.
46. Energy life cycle assessment for the production of biodiesel from rendered lipids in the United States. *Industrial & Engineering Chemistry Research* 49, no. 5 López, Dora E., Joseph C. Mullins, and David A. Bruce. (2010): 2419-2432. <http://pubs.acs.org/doi/abs/10.1021/ie900884x>
47. Detailed California-Modified GREET Pathway for Biodiesel Produced in the Midwest from Used Cooking Oil and Used in California, Version 2.0. CARB, June 30, 2011. <http://www.arb.ca.gov/fuels/lcfs/2a2b/internal/15day-mw-uco-bd-rpt-022112.pdf>
48. Influence of corn oil recovery on life-cycle greenhouse gas emissions of corn ethanol and corn oil biodiesel. Wang et al. *Biotechnol Biofuels* (2015) 8:178 DOI 10.1186/s13068-015-0350-8
49. Draft Argonne National Laboratory Research Note: Updated Parameters of Canola Biofuel Production Pathways in GREET Canola Council of Canada (CCC), Hao Cai, Jeongwoo Han, Amgad Elgowainy, and Michael Wang, 2013. Development of Aggregated Regional GHG Emission Values for Canola Production in Canada. Final Report.
50. Parameters of Canola Biofuel Production Pathways in GREET, Hao Cai, Jeongwoo Han, Amgad Elgowainy, and Michael Wang, September 2015.

51. Updates to Parameters of Hydrogen Production Pathways in GREET, Amgad Elgowainy, Jeongwoo Han, and Hao Zhu, October 7, 2013, Argonne National Laboratory <https://greet.es.anl.gov/publication-h2-13>
52. Explanatory Footnote.
53. Energy Efficiency and Greenhouse Gas Emission Intensity of Petroleum Products at U.S. Refineries Amgad Elgowainy, Jeongwoo Han, Hao Cai, Michael Wang, Grant S. Forman , Vincent B. Divita, May 2014.  
<https://greet.es.anl.gov/publication-energy-efficiency-refineries>.
54. Updated Fugitive Greenhouse Gas Emissions for Natural Gas Pathways in the GREET Model, Argonne National Laboratory, Andrew Burnham, Jeongwoo Han, Amgad Elgowainy, and Michael Wang. October 2013.  
<https://greet.es.anl.gov/publication-ch4-updates-13>
55. Updated Fugitive Greenhouse Gas Emissions for Natural Gas Pathways in the GREET Model, Argonne National Laboratory, Andrew Burnham, Jeongwoo Han, Amgad Elgowainy, and Michael Wang. October 2013.  
<https://greet.es.anl.gov/publication-ch4-updates-13>
56. Explanatory Footnote.

### **CA-GREET3.0 Lookup Table Pathways**

1. Explanatory Footnote.
2. Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Model Version 2.0b, El-Houjeiri, H.M., Vafi, K., Masnadi, M.S., Duffy, J., McNally, S., Sleep, S., Pacheco, D., Dashnadi, Z., Orellana, O., MacLean, H., Englander, J., Bergerson, J and A.R. Brandt. Nov 30th, 2017.
3. Energy Efficiency and Greenhouse Gas Emission Intensity of Petroleum Products at U.S. Refineries Amgad Elgowainy, Jeongwoo Han, Hao Cai, Michael Wang, Grant S. Forman, Vincent B. Divita, Published May 28, 2014.
4. Explanatory Footnote.
5. California's 2000-2012 Greenhouse Gas Emissions Inventory Technical Support Document. State of California Air Resources Board. Air Quality Planning and Science Division. CARB, May 2014.
6. Explanatory Footnote.
7. Annual Energy Outlook 2015. Table: Oil and Gas Supply. Case: Reference case. U.S. Energy Information Administration Webpage, accessed December 13, 2017. Available at:  
<http://www.eia.gov/beta/aeo/#/?id=14-AEO2015&cases=ref2015>



8. Supply and Demand, California Energy Commission webpage, accessed on February 7, 2018. Available at:  
[http://www.energy.ca.gov/almanac/naturalgas\\_data/overview.html](http://www.energy.ca.gov/almanac/naturalgas_data/overview.html)
9. Natural gas resource areas and interstate pipelines into California from California Energy Commission Website accessed February 7, 2018. Available at:  
[http://www.energy.ca.gov/almanac/naturalgas\\_data/interstate\\_pipelines.html](http://www.energy.ca.gov/almanac/naturalgas_data/interstate_pipelines.html)
10. Updated Fugitive Greenhouse Gas Emissions for Natural Gas Pathways in the GREET1\_2016 Model., Table 3, Page 6, A. Burham, Systems Assessment Group Energy Systems Division, Argonne National Laboratory, October 2016.
11. Explanatory Footnote.
12. Life-Cycle analysis of Shale Gas and Natural Gas Clark, et al. Argonne National Laboratory, ANL/ESD/11-11, December 2011.
13. Explanatory Footnote.
14. Explanatory Footnote.
15. Explanatory Footnote.
16. Propane Vehicles California Energy Commission Website, accessed on February 9, 2018. Available at: <http://www.energy.ca.gov/drive/technology/propane.html>
17. Petroleum & Other Liquids, Supply and Disposition, West Coast (PADD 5), Annual 2014, U.S. Energy Information Administration Website, accessed February 7, 2018. Available at:  
[https://www.eia.gov/dnav/pet/pet\\_sum\\_snd\\_d\\_r50\\_mbbbl\\_a\\_cur-2.htm](https://www.eia.gov/dnav/pet/pet_sum_snd_d_r50_mbbbl_a_cur-2.htm)
18. Explanatory Footnote.
19. Explanatory Footnote.
20. 2016 California Total System Electric Generation data from California Energy Commission (CEC) website, accessed January 3, 2018. Available at  
[http://www.energy.ca.gov/almanac/electricity\\_data/total\\_system\\_power.html](http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html)
21. Explanatory Footnote.
22. U.S. Energy Information Administration. List of plants for other, United States, all sectors, 2014 Webpage, accessed January 3, 2018. Available at:  
<https://www.eia.gov/electricity/data/browser/#/topic/1?agg=2,0,1&fuel=00g&geo=g&sec=g&freq=A&datecode=2014&rtype=s&pin=&rse=0&maptype=0&ltype=pin&ctype=linechart&end=2016&start=2014>
23. U.S. Energy Information Administration. Form EIA-923 detailed data, Webpage, accessed on: January 3, 2018. Available at:  
<http://www.eia.gov/electricity/data/eia923>
24. Updated Greenhouse Gas and Criteria Air Pollutant Emission Factors of the U.S. Electric Generating Units in 2010. Hao Cai, Michael Wang, Amgad Elgowainy, Jeongwoo Han. September, (2013).

25. CAISO, 2017. Historical Production and Curtailment Data now Posted to ISO website, accessed February 7, 2018.
26. Explanatory Footnote.
27. Explanatory Footnote.
28. Explanatory Footnote.
29. Explanatory Footnote.
30. Explanatory Footnote.

### **Tier 1 Simplified CI Calculator Instruction Manual Starch and Corn Fiber Ethanol**

1. 40 CFR Part 80 Regulation of Fuels and Fuel Additives RFS Pathways II, and Technical Amendments to the RFS Standards and E15 Misfueling Mitigation Requirements U.S.EPA Final Rule.
2. The Energy Balance of Corn Ethanol: An Update –Table 2. Shapouri et al. USDA July 2002.
3. Maps & Shipping Locations BNSF railway system webpage, accessed on February 12, 2018. Available at: <http://www.bnsf.com/customers/where-can-i-ship/>
4. State by State Guide to the Union Pacific Union Pacific webpage, accessed on February 12, 2018. Available at: <https://www.up.com/aboutup/usguide/index.htm>
5. Explanatory Footnote.
6. RFS code, section 80.1426. 40 CFR Ch. I (7-11-11 Edition).

### **Tier 1 Simplified CI Calculator Instruction Manual Sugarcane-derived Ethanol**

1. Explanatory Footnote.

## **Tier 1 Simplified CI Calculator Instruction Manual Biodiesel and Renewable Diesel**

1. Maps & Shipping Locations BNSF railway system webpage, accessed on February 7, 2018 Available at: <http://www.bnsf.com/customers/where-can-i-ship/>
2. State by State Guide to the Union Pacific Union Pacific webpage, accessed on February 7, 2018. Available at: <https://www.up.com/aboutup/usguide/index.htm>
3. Voyage Planner. MarineTraffic Webpage, accessed on February 12, 2018. Available at: <https://www.marinetraffic.com/en/voyage-planner>
4. Online nautical distance mapping system, Metric Conversions webpage, accessed on February 7, 2018. Available at: <http://www.metric-conversions.org/length/uk-nautical-miles-to-miles.htm>
5. Explanatory Footnote.
6. Emissions & Generation Resource Integrated Database (eGRID) - U.S EPA Webpage, Revised Release (v2): 2/27/2017. Last updated June 1, 2017. Available at: <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>
7. Explanatory Footnote
8. Emissions & Generation Resource Integrated Database (eGRID) - U.S EPA, Revised Release (v2): 2/27/2017. Last updated June 1, 2017. Available at: <https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>
9. Explanatory Footnote.

## **Tier 1 Simplified CI Calculator Instruction Manual LNG and L-CNG from North American Natural Gas**

No References

## **Tier 1 Simplified CI Calculator Instruction Manual Biomethane from North American Landfills**

No References

## **Appendix D      CEQA**

Please see Appendix D for a list of references.

## **Appendix E      Summary of DOF Comments to the Low Carbon Fuel Standard 2018 Amendments SRIA and CARB Responses**

1. Explanatory Footnote.
2. Explanatory Footnote.
3. Figure 1, 2011-2016 Performance of the Low Carbon Fuel Standard. LCFS Data Dashboard, Website accessed October 25, 2017. Available at: <https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>
4. Figure 2, Alternative Fuel Volumes and Credit Generation. LCFS Data Dashboard Website, accessed October 25, 2017. Available at: <https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>
5. Figure 11, Map of LCFS Beneficiaries. LCFS Data Dashboard Website, accessed October 25, 2017. Available at: <https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>
6. Figure 9, LCFS Credit Market Net Position Histogram. LCFS Data Dashboard Website, accessed October 25, 2017. Available: <https://www.arb.ca.gov/fuels/lcfs/dashboard/dashboard.htm>.
7. Monthly LCFS Credit Transfer Activity Report for March 2017 CARB Website, Posted on April 11, 2017. Available at: [https://www.arb.ca.gov/fuels/lcfs/credit/20170411\\_marcreditreport.pdf](https://www.arb.ca.gov/fuels/lcfs/credit/20170411_marcreditreport.pdf)
8. The Draft 2017 Climate Change Scoping Plan CARB, October 27, 2017.
9. 2016 Mobile Source Strategy CARB May 2016.
10. Reducing Carbon Dioxide Emissions from Aircraft Center for Climate and Energy Solution Website, accessed on October 25, 2017. Available at: <https://www.c2es.org/federal/executive/epa/reducing-aircraft-carbon-emissions>
11. Low Carbon Fuel Standard: Evaluation of jet fuel inclusion. Public Working Meeting for Stakeholder Groups, CARB Presentation, March 17, 2017.
12. Evaluation of Bio-Derived Synthetic Paraffinic Kerosenes (Bio2SPK), Committee D02 on Petroleum Products and Lubricants, Subcommittee D02.J0.06 on Emerging Turbine Fuels, Research Report D02-1739, ASTM International, West Conshohocken, PA, 28 June 2011. Boeing Company, UOP, U.S. Air Force Research Laboratory, 2011.  
  
Evaluation of Synthesized Iso-Paraffins Produced from Hydroprocessed Fermented Sugars (SIP Fuels), Final Version (3.), Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants, Subcommittee D02.J0 on Aviation Fuels, Research

Report D02-1776, ASTM International, West Conshohocken, PA, 15. Roland, O. and Garcia, F., 2014. TOTAL New Energies, Amyris, Inc., U.S. Air Force Research Laboratory, June 2014.

Evaluation of Alcohol to Jet Synthetic Paraffinic Kerosenes (ATK2SPK), Report Version (1.10), Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants, Subcommittee D02.J0 on Aviation Fuels, Research Report D02-1828, ASTM International, West Conshohocken, PA, 1 April 2016. Edwards, T., Meyer, D., Johnston, G., McCall, M., Rumizen, M., and Wright, M., 2016.

13. Alternative Fuels Tests on a C-17 Aircraft: Emissions Characteristics, Air Force Research Laboratory, Interim Report, AFRL-RZ-WP-TR-2011-2004, Wright-Patterson Air Force Base, OH, Corporan, E., DeWitt, M.J., Klingshirn, C.D., Anneken, D. December 2010.

Energy and Environmental Viability of Select Alternative Jet Fuel Pathways, 47th AIAA/ASME, SAE, ASEE Joint Propulsion Conference & Exhibit, San Diego, CA, AIAA 2011-15968, Carter, Nicholas A., Stratton, R.W., Bredehoeft, M.K., and Hileman, 31 July – 03 August 2011.

Impact of Alternative Fuels on Emissions Characteristics of a Gas Turbine Engine – Part 1: Gaseous and Particulate Matter Emissions. Environmental Science & Technology 2012 46 (19), 10805-10811. DOI: 10.1021/es301898u Lobo et al., 2012.

14. Explanatory Footnote.
15. California Health and Safety Code (H&SC), Sec 38530(a); and, Verification of GHG Emissions Data Reports CARB Webpage, accessed on October 25, 2017. Available at: <https://www.arb.ca.gov/cc/reporting/ghg-ver/ghg-ver.htm>
16. Offset Verification Program CARB website, accessed on October 25, 2017. Available at: <https://www.arb.ca.gov/cc/capandtrade/offsets/verification/verification.htm>
17. LCFS Reporting Tool (LRT), Credit Bank and Transfer System (CBTS) and the Alternative Fuels Portal (AFP). CARB Website accessed on October 25, 2017. Available at: <https://www.arb.ca.gov/fuels/lcfs/reportingtool/datamanagementsystem.htm#lrt-cbts>
18. Meeting Notice for Public Workshop to Discuss Potential Low Carbon Fuel Standard Rulemaking Items CARB, July 24, 2017.
19. Low Carbon Fuel Standard 2018 Amendments, Pre-Rulemaking Concept Paper. CARB, July 24, 2017.
20. Ibid.
21. Explanatory Footnote.
22. LCFS Meetings CARB webpage, accessed on October 25, 2017. Available at: <https://www.arb.ca.gov/cc/scopingplan/meetings/meetings.htm>

23. Appendix B: Development of Illustrative Compliance Scenarios and Evaluation of Potential Compliance Curves; LCFS Staff Report: Initial Statement of Reason. CARB, 2014.
24. 2016 Billion Ton Report. Advancing Domestic Resources for a Thriving Bioeconomy, Volume 1. Department of Energy, July 2016. Available at: <https://energy.gov/eere/bioenergy/2016-billion-ton-report>.
25. Landfill Technical Data. U.S.EPA Webpage, accessed October 30, 2017. Available at: <https://www.epa.gov/lmop/landfill-technical-data>
26. Livestock Anaerobic Digester Database U.S. EPA, AgStar, accessed October 30, 2017. Available at: <https://www.epa.gov/agstar/livestock-anaerobic-digester-database>
27. Biofuel Supply Module - Technical Documentation for Version 0.91 Beta. CARB. January 19, 2017.
28. The Draft 2017 Climate Change Scoping Plan CARB, October 27, 2017.
29. Explanatory Footnote.
30. Explanatory Footnote.
31. Explanatory Footnote.
32. Explanatory Footnote.
33. Title 17, California Code of Regulations (CCR), sections 95480-95497.
34. Explanatory Footnote.
35. Explanatory Footnote.
36. Explanatory Footnote.
37. Explanatory Footnote.
38. The List of Registered Parties in the LRT-CBTS CARB database. Available at: <https://www.arb.ca.gov/fuels/lcfs/lcfs.htm>. Accessed October 30, 2017.
39. The Draft 2017 Climate Change Scoping Plan CARB, October 27, 2017.
40. OMB circular A-4. Office of Management and Budget's (OMB), September 17, 2003.
41. Valuing Climate Damages: Updating Estimation of Carbon Dioxide. National Academies of Sciences, Engineering, and Medicine. (2017).
42. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 Interagency Working Group on Social Cost of Carbon, United States Government, May 2013; Revised July 2015.
43. CEPAM: 2016 SIP – Standard Emissions Tool CARB Data Base, available at: <https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>.

44. Quantitative Health Risk Assessment for Particulate Matter (Final Report). EPA-452/R-10-005 U.S. EPA, June 2010.
45. Explanatory Footnote.
46. Explanatory Footnote.
47. Guidelines for Preparing Economic Analyses, Appendix B: Mortality Risk Valuation Estimates. EPA 240-R-10-001. Washington, DC. December. U.S. EPA, National Center for Environmental Economics, Office of Policy Economics and Innovation, U.S. EPA, National Center for Environmental Economics, Office of Policy Economics and Innovation, 2010.
48. An SAB Report on EPA's White Paper Valuing the Benefits of Fatal Cancer Risk Reduction. EPA-SAB-EEAC-00-013. U.S. EPA, National Center for Environmental Economics, Office of Policy Economics and Innovation, 2010. U.S. EPA Science Advisory Board (U.S. EPA-SAB). 2000.
49. The Economic Value of Preventing Respiratory and Cardiovascular Hospitalizations. Contemporary Economic Policy, 24: 127–143. doi: 10.1093/cep/byj007 Chestnut, L. G., Thayer, M. A., Lazo, J. K. and Van Den Eeden, S. K. 2006.
50. Final Regulation Order, Amendments to the Regulation, Mandatory Reporting of Greenhouse Gas Emissions Regulation. CARB, filed with Secretary of State September 1, 2017.
51. Explanatory Footnote.
52. California's Oil Refineries, California Energy Commission webpage, accessed on November 1, 2017. Available at:  
[http://energy.ca.gov/almanac/petroleum\\_data/refineries.html](http://energy.ca.gov/almanac/petroleum_data/refineries.html)
53. Explanatory Footnote.
54. Explanatory Footnote.
55. Explanatory Footnote.
56. Weekly Retail Gasoline and Diesel Prices. United States Energy Information Administration, Excel Sheet with latest data for October 30, 2017. Available at:  
[www.eia.gov/dnav/pet/pet\\_pri\\_gnd\\_dcus\\_sca\\_w.htm](http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sca_w.htm)
57. Senate Bill 1. SEC. 25. 2017-2018.
58. Ibid.
59. Explanatory Footnote.
60. Tax Rates – Special Taxes and Fees California State Board of Equalization Webpage, Accessed on October 31, 2017. Available at:  
[http://www.boe.ca.gov/sptaxprog/tax\\_rates\\_stfd.htm](http://www.boe.ca.gov/sptaxprog/tax_rates_stfd.htm)
61. Ibid.
62. Explanatory Footnote.



63. Progress Report for Reducing or Displacing the Consumption of Petroleum Products by the State Fleet. California Department of General Services, DGS (2016)
64. Explanatory Footnote
65. The PATHWAYS Model- Modelling Information/PATHWAYS Output tool. CARB Data Source, January 17, 2017. Available at: [www.arb.ca.gov/cc/scopingplan/meetings/meetings.htm](http://www.arb.ca.gov/cc/scopingplan/meetings/meetings.htm)
66. Progress Report for Reducing or Displacing the Consumption of Petroleum Products by the State Fleet. California Department of General Services, DGS (2016)
67. Communication with the California Energy Commission, June 15, 2017.
68. Gov. Code, §§ 11346.3, 11346.36; and  
1 Cal. Code Regulations, tit. 1 §§ 2000-2004; and  
Division 3—Department of Finance, Chapter 1. Standardized Regulatory Impact Assessment for Major Regulations:
69. Explanatory Footnote.
70. Explanatory Footnote.
71. Explanatory Footnote.
72. Explanatory Footnote.
73. Projections Prepared by Demographic Research Unit, California Department of Finance. February (2017), Available at: [http://www.dof.ca.gov/Forecasting/Demographics/projections/documents/P1\\_Race\\_Ethnicity.xlsx](http://www.dof.ca.gov/Forecasting/Demographics/projections/documents/P1_Race_Ethnicity.xlsx)
74. California State Gross Domestic Product (GDP), 1963 to 2016 U.S., Bureau of Economic Analysis, updated May 11, 2017.
75. 7d Paris Agreement. Status as at: 11-02-2018 05:00:31 EDT, United Nations, Paris, 12 December 2015.
76. Clean Fuel Standard Discussion Paper. Environment and Climate Change Canada. February 2017.
77. Clean Fuel Standard Government of Canada Webpage, accessed on February 17, 2018. Available at: <https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html>
78. Low Carbon Fuel Standard 2018 Amendments, Pre-Rulemaking Concept Paper. CARB. July 24, 2017.
79. Meeting Notice for Public Workshop to Discuss Potential Low Carbon Fuel Standard Rulemaking Items CARB, July 24, 2017.
80. Explanatory Footnote.
81. Title 17, California Code of Regulations (CCR), sections 95480-95497.

82. Explanatory Footnote.
83. Title 17, California Code of Regulations (CCR), sections 95480-95497.
84. Explanatory Footnote.
85. PATHWAYS Output Tool. CARB Data Source, January 17, 2017. available at: [www.arb.ca.gov/cc/scopingplan/meetings/meetings.htm](http://www.arb.ca.gov/cc/scopingplan/meetings/meetings.htm) or, [https://www.arb.ca.gov/cc/scopingplan/pathways\\_arb\\_2.4.1\\_101917.zip](https://www.arb.ca.gov/cc/scopingplan/pathways_arb_2.4.1_101917.zip)
86. Explanatory Footnote.
87. Explanatory Footnote.
88. Explanatory Footnote.
89. Quantitative Health Risk Assessment for Particulate Matter (Final Report). U.S. EPA, 2010.
90. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F. U.S. EPA, 2009.
91. Ibid.
92. Estimate of Premature Deaths Associated with Fine Particle Pollution (PM<sub>2.5</sub>) in California Using a U.S. Environmental Protection Agency Methodology. CARB, August 31, 2010.
93. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F. U.S. EPA, 2009.
94. Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. Health Effects Institute Research Report 140. Krewski et al., 2009.
95. The burden of air pollution: impacts among racial minorities. Environmental Health Perspectives; 109(4):501–6. Gwynn, RC and Thurston, GD., 2001.
96. Proposed Regulatory Amendments to the Heavy-Duty Vehicle Inspection Program and Periodic Smoke Inspection Program SRIA. CARB, August 10 2017.
97. Intake fraction of primary pollutants: motor vehicle emissions in the South Coast Air Basin. Atmospheric Environment 37 (2003) 3455–3468. Marshall, J.D., Teoh, S., and Nazaroff, W. 2003.
98. Occupational Employment Statistics. Bureau of Labor Statistics, Occupational Profiles. May 2016.
99. Explanatory Footnote.
100. Renewable Identification Numbers (RINs) under the Renewable Fuel Standard Program. U.S.EPA Webpage accessed on November 1, 2017. Available at: <https://www.epa.gov/renewable-fuel-standard-program/renewable-identification-numbers-rins-under-renewable-fuel-standard>

101. Health Expenditures by State of Provider Centers for Medicare & Medicaid Services, data files released by the CMS Office of the Actuary on June 14, 2017. Available at: <http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/Downloads/provider-state2014.zip>
102. Expenditure Reports from MBES/CBES Medicaid.gov Webpage, accessed on November 1, 2017. Available at: <https://www.medicaid.gov/medicaid/financing-and-reimbursement/state-expenditure-reporting/expenditure-reports/index.html>
103. Analysis of the Medi-cal Budget Legislative Analyst's Office (LAO) Report March 9, 2017.
104. Federal and State Share of Medicaid Spending- Timeframe: FY 2016, Urban Institute estimates based on data from CMS (Form 64), January 2017. The Henry J. Kaiser Family Foundation. Available at: <http://www.kff.org/medicaid/state-indicator/federalstate-share-of-spending/?currentTimeframe=0&selectedRows=%7B%22states%22:%7B%22california%22:%7B%7D%7D%7D&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D#notes>.
105. Evaluation of Bio-Derived Synthetic Paraffinic Kerosenes (Bio2SPK), Committee D02 on Petroleum Products and Lubricants, Subcommittee D02.J0.06 on Emerging Turbine Fuels, Research Report D02-1739, ASTM International, West Conshohocken, PA, 28 June 2011. Boeing Company, UOP, U.S. Air Force Research Laboratory, 2011.
106. 2017 Edition of CARB's GHG Emission Inventory, fuel combustion activity data. Tenth Edition: 2000 to 2015 - Last updated on 6/6/2017, CARB, 2017.
107. Explanatory Footnote.
108. Progress Report for Reducing or Displacing the Consumption of Petroleum Products by the State Fleet. California Department of General Services, DGS (2016)
109. CEC Communication, June 15, 2017.
110. Explanatory Footnote.
111. Explanatory Footnote.
112. Concepts and Methods of the Input-Output Account. U.S. Department of Commerce, Bureau of Economic Analysis, Horowitz, Karen J. and Planting, Mark A., September 2006; Updated April 2009.
113. Documentation of data sources and methodology behind REMI's IO table can be found at: <http://www.remi.com/resources/documentation> . Accessed November 1, 2017.
114. Explanatory Footnote.
115. Explanatory Footnote.
116. Explanatory Footnote.
117. Dairy Data, Milk Cows and Production by State and Region (Annual: for years 2012-2016), Source: USDA Website. Available at:

[https://www.ers.usda.gov/webdocs/DataFiles/48685/milkcowsandprod\\_1.xlsx?v=42866](https://www.ers.usda.gov/webdocs/DataFiles/48685/milkcowsandprod_1.xlsx?v=42866)

118. Senate Bill 1383. 2017-2018.
119. Diamond Green Diesel expanding production capacity to 275 million gallons per year. Lux Research. Yu, Yuan-Sheng, April 19, 2016.
120. SLCP Final Report – Appendix F, Table 14. CARB, March 14, 2017.
121. Uncovering the Cost of Cellulosic Ethanol Production Lux Research, Yu, Yuan-Sheng, Oh, Victor, & Giles, Brent. January 19, 2016.
122. The Aemetis Biorefinery: Low Carbon Renewable Fuel for California. Aemetis Presentation to CARB. April 28, 2017.
123. The Impact of Solar Powered Oil Production on California’s Economy An economic analysis of Innovative Crude Production Methods under the LCFS. ICF International, January 2015.
124. Illinois State Geological Survey, Evaluation of CO2 Capture Options from Ethanol Plants U.S. Department of Energy Contract: DE-FC26-05NT42588, Report Issued: October 31, 2006.

## Appendix F      Methodologies for Estimating Potential GHG and Criteria Pollutant Emissions Changes due to the Proposed LCFS Amendments

1. Explanatory Footnote.
2. Dairy Data, Milk Cows and Production by State and Region (Annual: Years: 2012-2016), Source: USDA Website. Available at: [https://www.ers.usda.gov/webdocs/DataFiles/48685/milkcowsandprod\\_1.xlsx?v=42866](https://www.ers.usda.gov/webdocs/DataFiles/48685/milkcowsandprod_1.xlsx?v=42866)
3. Facility Search Engine. CARB Website accessed on November 29, 2017. Available at: <https://www.arb.ca.gov/app/emsinv/facinfo/facinfo.php?dd=>
4. Potential Air Emission Impacts of Cellulosic Ethanol Production at Seven Demonstration Refineries in the United States, Journal of the Air & Waste Management Association, 60:9, 1118-1143. DOI: 10.3155/1047-3289.60.9.1118, Jones, Donna Lee, 2010.
5. Steam injection rates for California oil fields were obtained from monthly production and injection reports, accessed on February 12, 2018. at [ftp://ftp.consrv.ca.gov/pub/oil/monthly\\_production\\_reports/](ftp://ftp.consrv.ca.gov/pub/oil/monthly_production_reports/)
6. Argonne National Laboratory (ANL), The Greenhouse gases, Regulated Emissions, and Energy use in Transportation Model, (2016).
7. Criteria Emissions (CEPAM) 2016 SIP - Standard Emission Tool. CARB. Website, accessed on November 29, 2017. Available at: <https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>
8. Emission FACTors (EMFAC) 2014, CARB Website, accessed on November 29, 2017. Available at: <https://www.arb.ca.gov/msei/categories.htm>
9. The U.S. Supertruck Program Expediting the Development of Advanced Heavy-Duty Vehicle Efficiency Technologies, White Paper, The International Council on Clean Transportation (ICCT), June 2014.
10. Off-Road Diesel Emissions Inventory 2017, CARB Website, accessed on November 29, 2017. Available at: <https://www.arb.ca.gov/msei/ordiesel.htm>
11. Class I Rail Freight Fuel Consumption and Travel, U.S. Department of Transportation Website, accessed on November 29, 2017. Available at: [https://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/national\\_transportation\\_statistics/html/table\\_04\\_17.html](https://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/national_transportation_statistics/html/table_04_17.html)
12. Paramount, CA GreenJet Refinery, Presentation for facility scheduled for commercial production in the 1st quarter of 2015. Available at: [https://www.smgov.net/uploadedFiles/Departments/Airport/Sustainability/20150126\\_AltAir\\_Presentation.pdf](https://www.smgov.net/uploadedFiles/Departments/Airport/Sustainability/20150126_AltAir_Presentation.pdf)

13. Energy savings by light-weighting – II, Final Report, Heidelberg, Germany, Institute for Energy and Environmental Research (IFEU), June 2004.
14. LARGE Aeronautics Data file Listing. The NASA Langley Aerosol Research Group Website, accessed on November 30, 2017. Available at: <https://science.larc.nasa.gov/large/data>
15. Comparison of PM Emissions from a Commercial Jet Engine Burning Conventional, Biomass, and Fischer-Tropsch Fuels, Environmental Science & Technology, Lobo, Prem, Hagen, D.E., Whitefield, P.D., 2011, 45 (24), pp 10744–10749.
16. Energy and Environmental Viability of Select Alternative Jet Fuel Pathways, 47th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit, San Diego, CA, AIAA 2011-5968, Carter, Nicholas A., Stratton, R.W., Bredehoeft, M.K., and Hileman, J.I., July 31- August 03, 2011.
17. Vision Scenario Planning: Downloads CARB Website, accessed: November 30, 2017. Available at: <https://www.arb.ca.gov/planning/vision/downloads.htm>
18. Evaluation of Bio-Derived Synthetic Paraffinic Kerosenes (Bio-SPKs), Report Version 5.0, Committee D02 on Petroleum Products and Lubricants, Subcommittee D02.J0.06 on Emerging Turbine Fuels, Research Report D02-1739, ASTM International, West Conshohocken, PA, Boeing Company, UOP, U.S. Air Force Research Laboratory, June 28, 2011.
19. Combustion Products of Petroleum Jet Fuel, a Fischer-Tropsch Synthetic Fuel, and a Biomass Fatty Acid Methyl Ester Fuel for a Gas Turbine Engine, Combustion Science and Technology, 183:10, 1039-1068, DOI: 10.1080/00102202.2011.581717, Timko, Michael T., Herndon, S.C., Blanco, d.E., Wood, E.C., Yu, Z., Miake-Lye, R.C., Knighton, W.B., Shafer, L., DeWitt, M.J., Corporan, E., 2011.
20. Chemical, Thermal Stability, Seal Swell, and Emissions Studies of Alternative Jet Fuels, Energy & Fuels, 25, 955-966, Corporan, Edwin, Edwards, T., Shafer, L., DeWitt, M.J., Klingshirn, C.D., Zabarnick, S., West, Z., Striebich, R., Graham, J., Klein, J., 2011.
21. Evaluation of Alcohol to Jet Synthetic Paraffinic Kerosenes (ATJ-SPKs), Report Version (1.10), Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants, Subcommittee D02.J0 on Aviation Fuels, Research Report D02 1828, ASTM International, West Conshohocken, PA, 1 Edwards, Tim, Meyer, D., Johnston, G., McCall, M., Rumizen, M., Wright, M., April 2016.

## **Appendix G: Supplemental Disclosure of Oxides of Nitrogen Potentially Caused by the Low Carbon Fuel Standard**

1. Fresno County Superior Court Order Modifying and Reissuing the Writ, POET, LLC. v. CARB, No. 09 CECG 04659 JYH (October 18, 2017).
2. California Code of Regulations, title 17, § 95480 et seq.; and California Code of Regulations, title 13, § 2293 et seq.
3. Explanatory Footnote.
4. Explanatory Footnote.
5. Explanatory Footnote.
6. Explanatory Footnote.
7. Explanatory Footnote.
8. Explanatory Footnote.
9. Impacts of Anthropogenic and Natural NO<sub>x</sub> Sources Over the U.S. on Tropospheric Chemistry Zhang et al., PNAS: February 18, 2003; vol. 100; no. 4
10. Explanatory Footnote.
11. Explanatory Footnote.
12. Explanatory Footnote.
13. Explanatory Footnote.
14. Responses to Comments on the Draft Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.
15. Cal. Pub. Resources Code § 21002.
16. Title 14 CCR. Section 15126.6. Available at: [https://govt.westlaw.com/calregs/Document/IB7E1C180D48811DEBC02831C6D6C108E?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=\(sc.Default\)](https://govt.westlaw.com/calregs/Document/IB7E1C180D48811DEBC02831C6D6C108E?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default))
17. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.
18. Explanatory Footnote.
19. Explanatory Footnote.
20. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.
21. See, e.g., 42 U.S.C. § 7545(o)(2)(B)(i)(I)(IV).
22. POET, LLC v. Cal. Air Resources Bd. (2013) 218 Cal.App.4th 681, 697.

23. Id.
24. Id.
25. Proposed Regulation to Implement the Low Carbon Fuel Standard – Staff Report; Initial Statement of Reasons Volume 1. CARB. March 5, 2009.
26. Id.
27. Id.
28. Proposed Regulation on the Commercialization of Alternative Diesel Fuels; Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
29. Id.
30. Attachment D to Resolution 15-41: Findings and Statement of Overriding Consideration, 14; CARB. 2015.  
Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.  
Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
31. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.  
Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
32. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.  
Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
33. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
34. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.  
Proposed Regulation on the Commercialization of Alternative Diesel Fuels –, Appendix B, Technical Supporting Information CARB, January 2, 2015.



35. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.  
Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
36. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.
37. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.
38. Ibid.
39. Ibid.
40. Ibid.
41. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.  
Proposed Regulation on the Commercialization of Alternative Diesel Fuels, Appendix B, Technical Supporting Information CARB, January 2, 2015.
42. Proposed Regulation on the Commercialization of Alternative Diesel Fuels; Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
43. Ibid.
44. Regulation for In-Use Off-Road Diesel Vehicles Final Regulation Order. Title 13 California Code of Regulations (CCR), section 2449. CARB. 2011; and  
Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles. Final Regulation Order. Title 13, California Code of Regulations (CCR), Section 2025. CARB. December 31, 2014; and  
The Carl Moyer Program Fact Sheet. CARB 2013; and  
Proposition 1B: Movement Emission Reduction Program. Final 2015 Guidelines for Implementation. CARB June 2015; and  
Lower-Emission School Bus Program, 2008 Guidelines. CARB, April 15, 2008.
45. POET, LLC v. Cal. Air Resources Bd. (2017) 12 Cal.App.5th 52.
46. 12 Cal.App.5th at 56.
47. 12 Cal.App.5th at 79.
48. Low Carbon Fuel Standard Workshop: Introduction/Schedule. CARB. December 2, 2008.
49. Proposed Environmental Analysis Workplan for the California Low Carbon Fuel Standard. CARB. December 2, (2008).

50. Public Law 114–113, 114th Congress, December 18, 2015; Consolidated Appropriations ACT, 2016. 129 STAT. 2242
51. Title 26, Internal Revenue Code; §6426.
52. Renewable Fuel Standard Program, U.S. EPA Webpage, accessed on February 23, 2018. Available at: <https://www.epa.gov/renewable-fuel-standard-program/overview-renewable-fuel-standard> .
53. Public Law 108-357, 108<sup>th</sup> Congress, October 22, 2004; American Jobs Creation Act of 2004. 118 STAT. 1418
54. Public Law 112-240, 112<sup>th</sup> Congress, January 2, 2013; American Taxpayer Relief Act of 2012. 126 STAT. 2314
55. An Alternative View of Biodiesel Production Profits: The Role of Retroactively Reinstated Blender Tax Credits. farmdoc daily (7):57, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, Irwin, S. March 29, 2017.
56. Federal Register, Volume 72 No. 83. May 1, 2007. 40 CFR Part 80; Regulation of Fuels and Fuel Additives: Renewable Fuel Standard Program; Final Rule
57. Public Law 110-140, 110<sup>th</sup> Congress, January 4, 2007; Energy Independence and Security Act of 2007.
58. Federal Register, Volume 75 No. 58. March 26, 2010. 40 CFR Part 80; Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Final Rule
59. Explanatory Footnote.
60. Explanatory Footnote.
61. Explanatory Footnote.
62. Explanatory Footnote.
63. Explanatory Footnote.
64. Explanatory Footnote.
65. Low Carbon Fuel Standard Reporting Tool Quarterly Summaries CARB webpage, accessed on February 16, 2018. Available at: <https://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm>.
66. Explanatory Footnote.
67. Explanatory Footnote.
68. Explanatory Footnote.
69. Explanatory Footnote.
70. Explanatory Footnote.
71. Low Carbon Fuel Standard 2011 Program Review Report. Final Draft, CARB. December 8, 2011.

72. Low Carbon Fuel Standard Reporting Tool Quarterly Summaries CARB webpage, accessed on February 16, 2018. Available at: <https://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm>.
73. Explanatory Footnote.
74. Initial Statement of Reasons for Proposed Rulemaking – Proposed Re-Adoption of the Low Carbon Fuel Standard, Appendix B: Development of Illustrative Compliance Scenarios and Evaluation of Potential Compliance Curves. CARB 2014.
75. Initial Statement of Reasons for Proposed Rulemaking – Proposed Amendments to the Low Carbon Fuel Standard, Appendix D: Environmental Analysis. CARB. 2018.
76. Explanatory Footnote.
77. Explanatory Footnote.
78. Explanatory Footnote.
79. Explanatory Footnote.
80. Explanatory Footnote.
81. Explanatory Footnote.
82. Explanatory Footnote.
83. Explanatory Footnote.
84. Explanatory Footnote.
85. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
86. CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California; Biodiesel Characterization and NOx Mitigation Study Durbin, et al. October, 2011.
87. Explanatory Footnote.
88. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
89. Ibid.
90. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.

- CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California; Biodiesel Characterization and NOx Mitigation Study Durbin, et al. October 2011.
91. CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California; Biodiesel Characterization and NOx Mitigation Study Durbin, et al. October 2011.
  92. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
  93. CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California; Biodiesel Characterization and NOx Mitigation Study Durbin, et al. October 2011.
  94. CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California; Biodiesel Characterization and NOx Mitigation Study Durbin, et al. October 2011.
  95. Ibid.
  96. Ambient Air Quality Standards. CARB. May 4, 2016.
  97. Revised Proposed 2016 State Strategy for the State Implementation Plan. CARB. March 7, 2017.
  98. California State Implementation Plans CARB Webpage, accessed on February 15, 2018. Available at: <https://www.arb.ca.gov/planning/sip/sip.htm>
  99. Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles. Final Regulation Order. Title 13, California Code of Regulations (CCR), Section 2025. CARB. December 31, 2014.
  100. Regulation for In-Use Off-Road Diesel Vehicles Final Regulation Order. Title 13 California Code of Regulations (CCR), section 2449. CARB. 2011.
  101. The Carl Moyer Program Guidelines, 2017 Revisions, Volume 1: Program Overview, Program Administration, and Project Criteria. CARB. Proposed March 10, 2017.
  102. Proposition 1B: Movement Emission Reduction Program. Final 2015 Guidelines for Implementation. CARB. June 2015.
  103. Lower-Emission School Bus Program, 2008 Guidelines. CARB. April 15, 2008
  104. CEPAM: 2016 SIP - Standard Emission Tool CARB Webpage, accessed on February 16, 2018. Available at: <https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>.
  105. Ibid.

106. Environmental Checklist Form California Code of Regulations (CCR). Title 14, Appendix G. 2017. Westlaw Webpage accessed on February 23, 2018. Available at:  
[https://govt.westlaw.com/calregs/Document/I1D6750F63775483A8F7861C335CD6854?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=\(sc.Default\)](https://govt.westlaw.com/calregs/Document/I1D6750F63775483A8F7861C335CD6854?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default))
107. Explanatory Footnote.
108. Explanatory Footnote.
109. Explanatory Footnote.
110. Explanatory Footnote.
111. Explanatory Footnote.
112. Environmental Checklist Form California Code of Regulations (CCR). Title 14, Appendix G. 2017. Westlaw Webpage accessed on February 23, 2018. Available at:  
[https://govt.westlaw.com/calregs/Document/I1D6750F63775483A8F7861C335CD6854?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=\(sc.Default\)](https://govt.westlaw.com/calregs/Document/I1D6750F63775483A8F7861C335CD6854?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default))
113. Explanatory Footnote.
114. Explanatory Footnote.
115. Explanatory Footnote.
116. Ambient Air Quality Standards. CARB. May 4, 2016.
117. Revised Proposed 2016 State Strategy for the State Implementation Plan. CARB. March 7, 2017.
118. Area Designations for State Ambient Air Quality Standards – Nitrogen Dioxide. Air Quality Planning Branch, AQPSD, CARB. December 2015.
119. Area Designations for National Ambient Air Quality Standards – Nitrogen Dioxide. Air Quality Planning Branch, AQPSD, CARB. December 2015
120. CEPAM: 2016 SIP - Standard Emission Tool CARB Webpage, accessed on February 16, 2018. Available at:  
<https://www.arb.ca.gov/app/emssinv/fcemssumcat/fcemssumcat2016.php>.
121. Rethinking the Ozone Problem in Urban and Regional Air Pollution. Washington, DC. The National Academies Press. pp. 163-168. National Research Council. 1991.  
  
Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
122. Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.

123. Explanatory Footnote.
124. Rethinking the Ozone Problem in Urban and Regional Air Pollution. Washington, DC. The National Academies Press. pp. 163-168. National Research Council. 1991.
- Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
125. Explanatory Note.
126. Rethinking the Ozone Problem in Urban and Regional Air Pollution. Washington, DC. The National Academies Press. pp. 163-168. National Research Council. 1991.
- Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
127. Explanatory Footnote.
128. Revised Proposed 2016 State Strategy for the State Implementation Plan. CARB. March 7, 2017.
129. Explanatory Footnote.
130. Area Designations for National Ambient Air Quality Standards – 8-Hour Ozone. CARB. Air Quality Planning Branch, AQPSD, December 2015.
131. Revised Proposed 2016 State Strategy for the State Implementation Plan. CARB. March 7, 2017.
132. Explanatory Footnote.
133. Explanatory Footnote.
134. Area Designations for National Ambient Air Quality Standards – 8-Hour Ozone. CARB. Air Quality Planning Branch, AQPSD, December 2015.
135. Revised Proposed 2016 State Strategy for the State Implementation Plan. CARB. March 7, 2017.
136. Explanatory Footnote.
137. California Environmental Quality Act Air Quality Guidelines. Bay Area Air Quality Management District. May (2017).
- CEQA Air Quality Handbook. Butte County Air Quality Management District. October 23, 2014.
- Indirect Source Review Guidelines. Feather River Air Quality Management District. June 7, 2010.

SMAQMD Thresholds of Significance Table. Sacramento Metropolitan Air Quality Management District. (2015).

Air Quality Thresholds of Significance – Criteria Pollutants. San Joaquin Valley Air Pollution Control District. March 19, 2015.

Environmental Thresholds and Guidelines Manual. County of Santa Barbara Planning and Development. Published October 2008, Revised July 2015.

SCAQMD Air Quality Significance Thresholds. South Coast Air Quality Management District. Revision: March 2015.

Ventura County Air Quality Assessment Guidelines. Ventura County Air Pollution Control District. October 2003.

138. Ozone and Ambient Air Quality Standards. CARB Webpage, accessed on February 16, 2018. Available at: <https://www.arb.ca.gov/research/aaqs/caaqs/ozone/ozone.htm>.
139. Area Designations for State Ambient Air Quality Standards – Ozone. CARB, Air Quality Planning Branch, AQPSD; June 2017.
140. Area Designations for National Ambient Air Quality Standards – 8-Hour Ozone. CARB, Air Quality Planning Branch, AQPSD, Last Reviewed December 2015. Available at: [https://www.arb.ca.gov/desig/adm/2015/fed\\_o3.pdf](https://www.arb.ca.gov/desig/adm/2015/fed_o3.pdf).
141. Explanatory Footnote.
142. Explanatory Footnote.
143. Explanatory Footnote.
144. Explanatory Footnote.
145. Explanatory Footnote.
146. Overview: Diesel Exhaust and Health. CARB Webpage, accessed February 23, 2018. Available at: <https://www.arb.ca.gov/research/diesel/diesel-health.htm>.
147. Ozone and Ambient Air Quality Standards. CARB Webpage, accessed on February 16, 2018. Available at: <https://www.arb.ca.gov/research/aaqs/caaqs/ozone/ozone.htm>.
148. Explanatory Footnote.
149. Explanatory Footnote.
150. Explanatory Footnote.
151. Explanatory Footnote.
152. Explanatory Footnote.
153. Explanatory Footnote.
154. Explanatory Footnote.
155. Explanatory Footnote.

156. Explanatory Footnote.
157. Explanatory Footnote.
158. Explanatory Footnote.
159. Explanatory Footnote.
160. Explanatory Footnote.
161. Explanatory Footnote.
162. Explanatory Footnote.
163. Explanatory Footnote.
164. Explanatory Footnote.
165. Explanatory Footnote.
166. Explanatory Footnote.
167. Rethinking the Ozone Problem in Urban and Regional Air Pollution. Washington, DC. The National Academies Press. pp. 163-168. National Research Council. 1991.  
  
Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
168. Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
169. Initial Statement of Reasons for Review of the California Ambient Air Quality Standard for Ozone, Volume IV of IV, Appendices B-G, October 27, 2005 Revision.
170. iADAM: Air Quality Data Statistics CARB iADAM database, accessed on February 16, 2018. iADAM: Air Quality Data Statistics. Available at: <https://www.arb.ca.gov/adam>.
171. Precursor reductions and ground-level ozone in the Continental United States, Journal of the Air & Waste Management Association 65:10, 1261-1282. Hidy, George M. and Charles L. Blanchard. 2015.
172. Explanatory Note.
173. Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles. Final Regulation Order. Title 13, California Code of Regulations (CCR), Section 2025. CARB, December 31, 2014.
174. Regulation for In-Use Off-Road Diesel Vehicles Final Regulation Order. Title 13 California Code of Regulations (CCR), section 2449. CARB. 2011.



175. The Carl Moyer Program Guidelines, 2017 Revisions, Volume 1: Program Overview, Program Administration, and Project Criteria. CARB. Proposed March 10, 2017.
176. Proposition 1B: Movement Emission Reduction Program. Final 2015 Guidelines for Implementation. CARB. June 2015.
177. Lower-Emission School Bus Program, 2008 Guidelines. CARB, April 15, 2008
178. Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Proposed Amendments to the Low Carbon Fuel Standard and Alternative Diesel Fuels Regulations. CARB, March, 2018
179. Cal. Pub. Resources Code § 21002.
180. California Code of Regulations, Title 14, § 15126.6(a).
181. California Code of Regulations, Title 17, § 60000 – 60008.
182. California Code of Regulations, Title 17, § 60006.
183. California Code of Regulations, Title 14, § 15126.6(a).
184. California Code of Regulations, Title 14, § 15126.6(f).
185. California Code of Regulations, Title 14, § 15126.6(f)(3).
186. Senate Bill 32, Chapter 249, Statutes of 2016.
187. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.
188. Explanatory Footnote.
189. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.
190. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.
191. California Code of Regulations, title 13, § 2293 et seq.
192. Explanatory Footnote
193. Explanatory Footnote.
194. California Code of Regulations, title 13, § 2293 et seq.
195. Explanatory Footnote.
196. Appendix B – Final Environmental Analysis for the Low Carbon Fuel Standard and Alternative Diesel Fuel Regulations. CARB, September 21, 2015.

## Appendix 1: Attribution Methods

197. Antonakis, John, et al. Causality and endogeneity: Problems and solutions. The Oxford handbook of leadership and organizations 1 (2014): 93-117.
198. Weekly Retail Gasoline and Diesel Prices. U.S. EIA. 2017a. Accessed on February 18, 2018. Available at: [https://www.eia.gov/dnav/pet/pet\\_pri\\_gnd\\_dcus\\_sca\\_w.htm](https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sca_w.htm).
199. Weekly Credit Transfer Activity. Low Carbon Fuel Standard. Accessed on February 23, 2018. Available at: <https://lcfsint.arb.ca.gov/LCFSRT/>.
200. Low Carbon Fuel Standard Reporting Tool Quarterly Summaries. CARB website, accessed on February 16, 2018. Available at: <https://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm>. Accessed on May, 2017
201. Monthly Biodiesel Production Report. With data for April 2017. U.S. EIA. June 2017.
202. Net receipts of crude oil and petroleum products by pipeline, tanker, barge, and rail. Petroleum and Other Liquids. February. U.S. EIA. 2017. Accessed on February 23, 2018. Available at: [https://www.eia.gov/dnav/pet/pet\\_move\\_net\\_r10-z0p\\_VNR\\_mbbl\\_m.htm](https://www.eia.gov/dnav/pet/pet_move_net_r10-z0p_VNR_mbbl_m.htm).
203. Stocks by Type. Petroleum and Other Liquids. February. U.S. EIA. 2017d. Accessed on February 23, 2018. Available at: [https://www.eia.gov/dnav/pet/pet\\_stoc\\_typ\\_d\\_nus\\_SAE\\_mbbl\\_m.htm](https://www.eia.gov/dnav/pet/pet_stoc_typ_d_nus_SAE_mbbl_m.htm).
204. District Imports by Country of Origin. Petroleum and Other Liquids. February 2017. U.S. EIA, Webpage, accessed on February 23, 2018. Available at: [https://www.eia.gov/dnav/pet/pet\\_move\\_impcp\\_a2\\_r10\\_EPOORDB\\_im0\\_mbbl\\_m.htm](https://www.eia.gov/dnav/pet/pet_move_impcp_a2_r10_EPOORDB_im0_mbbl_m.htm)
205. Exports. Petroleum and Other Liquids. February, 2017. U.S. EIA, Webpage, accessed on February 23, 2018. Available at: [https://www.eia.gov/dnav/pet/pet\\_move\\_exp\\_dc\\_R10-Z00\\_mbbl\\_m.htm](https://www.eia.gov/dnav/pet/pet_move_exp_dc_R10-Z00_mbbl_m.htm)
206. Final Renewable Fuel Standards for 2017 and the Biomass-Based Diesel Volume for 2018. U.S. EPA Webpage, accessed on February 23, 2018. Available at: <https://www.epa.gov/renewable-fuel-standard-program/final-renewable-fuel-standards-2017-and-biomass-based-diesel-volume>
207. Product Supplied. Petroleum and Other Liquids. February 2017. U.S. EIA, Webpage, accessed on February 23, 2018. Available at: [https://www.eia.gov/dnav/pet/pet\\_cons\\_psup\\_dc\\_nus\\_mbbl\\_m.htm](https://www.eia.gov/dnav/pet/pet_cons_psup_dc_nus_mbbl_m.htm)
208. Ordinary least squares estimation and time series. Regression and Multivariate Data Analysis. Simonoff, JF. August 2016.
209. U.S. Biodiesel/Renewable Diesel Market. U.S. Department of Agriculture. Office of Global Analysis. Carter, Ernest. May 2016.
210. Explanatory Footnote.

211. California No 2 Diesel Ultra Low Sulfur (0-15 ppm) Retail Prices (Dollars per Gallon) EIA Excel Worksheet, Release date May 30, 2017
212. Public Law 114–113, 114th Congress, December 18, 2015; Consolidated Appropriations ACT, 2016. 129 STAT. 2242; and  
26 U.S. Code 6426 (accessed on February 25, 2018); and  
Why Do Blenders Share Retroactively Reinstated Tax Credits with Biodiesel Producers? Scott Irwin July 22, 2015; and  
Biodiesel blenders tax credit passes US House, Senate. Ron Kotrba, December 18, 2015.
213. Ex post costs and renewable identification number (RIN) prices under the Renewable Fuel Standard. Lade, Gabriel, C-Y. Cynthia Lin Lawell, and Aaron Smith. (2015).
214. Explanatory Footnote.
215. Explanatory Footnote.
216. California No 2 Diesel Ultra Low Sulfur (0-15 ppm) Retail Prices (Dollars per Gallon) EIA Excel Worksheet, Release date May 30, 2017.
217. Public Law 114–113, 114th Congress, December 18, 2015; Consolidated Appropriations ACT, 2016. 129 STAT. 2242; and  
26 U.S. Code 6426 (accessed on February 25, 2018);
218. Ex post costs and renewable identification number (RIN) prices under the Renewable Fuel Standard. Lade, Gabriel, C-Y. Cynthia Lin Lawell, and Aaron Smith. (2015).
219. Explanatory Footnote.
220. Explanatory Footnote.
221. Low Carbon Fuel Standard Reporting Tool Quarterly Summaries CARB webpage, Accessed on February 16, 2018. Available at:  
<https://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm>
222. Monthly Biodiesel Consumption Monthly Energy Review. DOE/EISA-0035(2017/6) U.S. Department of Energy. June 2017. Available at:  
<https://www.eia.gov/totalenergy/data/monthly/#renewable>
223. California Energy Commission Fuel Consumption Data (Years: 2003 – 2015). Source: California Energy Commission (CEC) analysis of Board of Equalization (BOE) taxable gasoline figures.
224. Strategic Assessment of Bioenergy Development in the West Spatial Analysis and Supply Curve Development.  
Kansas State University and the U.S. Forest Service. September 1, 2008  
Average US Freight Rail Rates Down Since Deregulation, Association of American Railroads Webpage, accessed on November 30, 2017. Available at:  
<https://www.aar.org/Pages/Average-US-Freight-Rail-Rates-Chart.aspx>.

225. Explanatory Footnote
226. Biofuels: Ethanol and Biodiesel Explained, Energy Explained Homepage, U.S. EIA Website, Accessed on February 23, 2018. Available at: [https://www.eia.gov/energyexplained/index.cfm?page=biofuel\\_biodiesel\\_use](https://www.eia.gov/energyexplained/index.cfm?page=biofuel_biodiesel_use)
227. Food vs. fuel: the effect of biofuel policies. American Journal of Agricultural Economics, Chen, X., Khanna, M., May 11, 2012; and  
Carter, Colin A., Gordon C. Rausser, and Aaron Smith. Commodity storage and the market effects of biofuel policies. American Journal of Agricultural Economics (2016): aaw010; and  
Cui, J., Lapan, H., Moschini, G., & Cooper, J. (2011). Welfare impacts of alternative biofuel and energy policies. American Journal of Agricultural Economics, aar053.

## Appendix 2: Statistical Analysis Methods and Results

No footnotes/References

## Appendix 3: Biomass-Based Diesel Volumes and Emissions and Health Impacts for Scenarios 3 and 4

- 228. Explanatory Footnote.
- 229. Explanatory Footnote.
- 230. Explanatory Footnote.
- 231. Explanatory Footnote.
- 232. Explanatory Footnote.
- 233. Explanatory Footnote.
- 234. Explanatory Footnote.
- 235. Low Carbon Fuel Standard 2011 Program Review Report. CARB. December 8, 2011.
- 236. Low Carbon Fuel Standard Reporting Tool Quarterly Summaries CARB webpage, accessed on February 16, 2018. Available at: <https://www.arb.ca.gov/fuels/lcfs/lrtqsummaries.htm>
- 237. Explanatory Footnote.
- 238. Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Proposed Re-Adoption of the Low Carbon Fuel Standard, Appendix B: Development of Illustrative Compliance Scenarios and Evaluation of Potential Compliance Curves. CARB. 2014.
- 239. Staff Report: Initial Statement of Reasons for Proposed Rulemaking – Proposed Amendments to the Low Carbon Fuel Standard, Appendix D: Environmental Analysis. CARB. March 2018.
- 240. Explanatory Footnote.
- 241. Explanatory Footnote.
- 242. Explanatory Footnote.
- 243. Explanatory Footnote.
- 244. Explanatory Footnote.
- 245. Explanatory Footnote.
- 246. Explanatory Footnote.
- 247. Explanatory Footnote.

248. California Code of Regulations (CCR). 2017. Title 14, Appendix G. Environmental Checklist Form. Westlaw Webpage accessed on February 23, 2018. Available at:  
[https://govt.westlaw.com/calregs/Document/I1D6750F63775483A8F7861C335CD6854?viewType=FullText&originationContext=documenttoc&transitionType=CategorizationPageItem&contextData=\(sc.Default\)](https://govt.westlaw.com/calregs/Document/I1D6750F63775483A8F7861C335CD6854?viewType=FullText&originationContext=documenttoc&transitionType=CategorizationPageItem&contextData=(sc.Default))
249. Explanatory Footnote.
250. Explanatory Footnote.
251. Explanatory Footnote.
252. Explanatory Footnote.
253. California Code of Regulations (CCR). 2017. Title 14, Appendix G. Environmental Checklist Form. Westlaw Webpage accessed on February 23, 2018. Available at:  
[https://govt.westlaw.com/calregs/Document/I1D6750F63775483A8F7861C335CD6854?viewType=FullText&originationContext=documenttoc&transitionType=CategorizationPageItem&contextData=\(sc.Default\)](https://govt.westlaw.com/calregs/Document/I1D6750F63775483A8F7861C335CD6854?viewType=FullText&originationContext=documenttoc&transitionType=CategorizationPageItem&contextData=(sc.Default))
254. Explanatory Footnote.
255. Explanatory Footnote.
256. Ambient Air Quality Standards. CARB. May 4, 2016.
257. Revised Proposed 2016 State Strategy for the State Implementation Plan. CARB. March 7, 2017.
258. Area Designations for State Ambient Air Quality Standards – Nitrogen Dioxide. Air Quality Planning Branch, AQPSD, CARB December 2015. Available at:  
[https://www.arb.ca.gov/desig/adm/2015/state\\_no2.pdf](https://www.arb.ca.gov/desig/adm/2015/state_no2.pdf).
259. Area Designations for National Ambient Air Quality Standards – Nitrogen Dioxide. Air Quality Planning Branch, AQPSD, CARB December 2015. Available at: [https://www.arb.ca.gov/desig/adm/2015/fed\\_no2.pdf](https://www.arb.ca.gov/desig/adm/2015/fed_no2.pdf).
260. CEPAM: 2016 SIP - Standard Emission Tool CARB Webpage, accessed on February 16, 2018. Available at:  
<https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>
261. Rethinking the Ozone Problem in Urban and Regional Air Pollution. Washington, DC. The National Academies Press. pp. 163-168. National Research Council. 1991.  
  
Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
262. Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
263. Explanatory Footnote.

264. Rethinking the Ozone Problem in Urban and Regional Air Pollution. Washington, DC. The National Academies Press. pp. 163-168. National Research Council. 1991.
- Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
265. Explanatory Footnote.
266. Rethinking the Ozone Problem in Urban and Regional Air Pollution. Washington, DC. The National Academies Press. pp. 163-168. National Research Council. 1991.
- Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
267. Explanatory Footnote.
268. Revised Proposed 2016 State Strategy for the State Implementation Plan. CARB. March 7, 2016.
269. Explanatory Footnote.
270. Area Designations for National Ambient Air Quality Standards – 8-hour Ozone. CARB. December 2015.
271. Revised Proposed 2016 State Strategy for the State Implementation Plan. CARB. March 7, 2016.
272. Explanatory Footnote.
273. Explanatory Footnote.
274. Area Designations for National Ambient Air Quality Standards – 8-hour Ozone. CARB, December 2015.
275. Revised Proposed 2016 State Strategy for the State Implementation Plan. CARB. March 7, 2016.
276. Explanatory Footnote.
277. California Environmental Quality Act Air Quality Guidelines. Bay Area Air Quality Management District May 2017.
- Air Quality Thresholds of Significance – Criteria Pollutants. San Joaquin Valley Air Pollution Control District. 2015.
- SCAQMD Air Quality Significance Thresholds. South Coast Air Quality Management District. March 2015.
278. Ozone and Ambient Air Quality Standards. October. CARB 2015.
279. Area Designations for State Ambient Air Quality Standards - Ozone. CARB. 2017.

280. Area Designations for National Ambient Air Quality Standards – 8-Hour Ozone. CARB. 2015.
281. Explanatory Footnote.
282. Explanatory Footnote.
283. Explanatory Footnote.
284. Explanatory Footnote.
285. Explanatory Footnote.
286. Explanatory Footnote.
287. Explanatory Footnote.
288. Ibid.
289. Explanatory Footnote.
290. Explanatory Footnote.
291. Explanatory Footnote.
292. Explanatory Footnote.
293. Explanatory Footnote.
294. Explanatory Footnote.
295. Explanatory Footnote.
296. Explanatory Footnote.
297. Explanatory Footnote.
298. Explanatory Footnote.
299. Explanatory Footnote.
300. Explanatory Footnote.
301. Explanatory Footnote.
302. Rethinking the Ozone Problem in Urban and Regional Air Pollution. Washington, DC. The National Academies Press. pp. 163-168. National Research Council. 1991.  
  
Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
303. Weekend/Weekday Ozone Observations in the South Coast Air Basin: Volume I – Executive Summary, Final Report. Fujita, Eric M., William R. Stockwell, David E. Campbell, Lyle R. Chinkin, Hilary H. Main, and Paul T. Roberts. 2002.
304. Initial Statement of Reasons for Review of the California Ambient Air Quality Standard for Ozone, Volume IV of IV, Appendices B-G, October 2005 Revision. CARB. October 27, 2005.



305. iADAM: Air Quality Data Statistics CARB iADAM database, accessed on February 16, 2018. iADAM: Air Quality Data Statistics. Available at: <https://www.arb.ca.gov/adam>.
306. Precursor reductions and ground-level ozone in the Continental United States, Journal of the Air & Waste Management Association 65:10, 1261-1282. Hidy, George M. and Charles L. Blanchard. 2015.
307. Explanatory Footnote.
308. Final Regulation Order. Title 13, California Code of Regulations (CCR), Section 2025. Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles. CARB. 2014. December 31. 2014.
309. Final Regulation Order. Title 13 California Code of Regulations (CCR), section 2449. Regulation for In-Use Off-Road Diesel Vehicles. CARB. 2011.
310. The Carl Moyer Program Guidelines, 2017 Revisions, Volume 1: Program Overview, Program Administration, and Project Criteria. CARB. Proposed March 10, 2017.
311. Proposition 1B: Movement Emission Reduction Program. Final 2015 Guidelines for Implementation. CARB. June 2015.
312. Lower-Emission School Bus Program, 2008 Guidelines. CARB, April 15, 2008

## **Appendix 4: Biomass-Based Diesel Volume and Emissions Analysis Equations**

- 313. Explanatory Footnote.
- 314. Explanatory Footnote.
- 315. Explanatory Footnote.

## **Appendix 5: LCFS NOx and PM Emissions Methodology**

316. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
317. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
318. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
319. Explanatory Footnote.
320. CARB Assessment of the Emissions from the Use of Biodiesel as a Motor Vehicle Fuel in California; Biodiesel Characterization and NOx Mitigation Study Durbin, et al. October 2011.
321. Explanatory Footnote.
322. Explanatory Footnote.
323. Final Regulation Order: Regulation on Commercialization of Alternative Diesel Fuels. CARB, November 15, 2015.
324. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
325. Explanatory Footnote.
326. Alternative Diesel Fuels Regulation Reporting Summary – 2016. CARB. August 2017.
327. Alternative Diesel Fuels Regulation Reporting Summary – 2016. CARB. August 2017.
328. Explanatory Footnote.
329. Explanatory Footnote.
330. Explanatory Footnote.
331. Explanatory Footnote.
332. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.

333. Explanatory Footnote.
334. CEPAM: 2016 SIP - Standard Emission Tool CARB Webpage, accessed on February 16, 2018. Available at:  
<https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>
335. Explanatory Footnote.
336. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
337. ARB Survey of California Refiners Regarding Renewable Diesel Blending Practices. CARB. June 2017.
338. Proposed Regulation on the Commercialization of Alternative Diesel Fuels – Staff Report: Initial Statement of Reasons. Industrial Strategies Division; Oil and Gas and GHG Mitigation Branch & Transportation Fuels Branch. CARB, January 2, 2015.
339. Staff Report – Multimedia Evaluation of Renewable Diesel. CARB, May 2015
340. Explanatory Footnote.
341. Explanatory Footnote.
342. Explanatory Footnote.
343. Explanatory Footnote.
344. Explanatory Footnote.
345. CEPAM: 2016 SIP - Standard Emission Tool CARB Webpage, accessed on February 16, 2018. Available at:  
<https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php>
346. CARB Survey of California Refiners Regarding Renewable Diesel Blending Practices. CARB. June 2017.
347. Staff Report – Multimedia Evaluation of Renewable Diesel. CARB, May 2015.
348. CARB. “Statewide LCFS NOx Analysis using 2015 EA Volumes (March 6, 2018).” Excel Workbook.  
CARB. “Air Basin LCFS NOx Analysis using 2015 LCFS EA Volumes (March 6, 2018).” Excel Workbook.  
CARB. “Air District LCFS NOx Analysis using 2015 LCFS EA Volumes (March 6, 2018).” Excel Workbook.  
CARB. “Statewide LCFS NOx Analysis using 2018 LCFS EA BAU Volumes (March 6, 2018).” Excel Workbook.  
CARB. “Air Basin LCFS NOx Analysis using 2018 LCFS EA BAU Volumes (March 6, 2018).” Excel Workbook.

CARB. "Air District LCFS NOx Analysis using 2018 LCFS EA BAU Volumes (March 6, 2018)." Excel Workbook.

CARB. "Mobile Source NOx Emissions by Air Basin (March 6, 2018)." Excel Workbook.

CARB. "Mobile Source NOx Emissions by Air District (March 6, 2018)." Excel Workbook.

CARB. "Statewide LCFS PM Analysis using 2015 LCFS EA Volumes (March 6, 2018)." Excel Workbook.

CARB. "Air Basin LCFS PM Analysis using 2015 LCFS EA Volumes (March 6, 2018)." Excel Workbook.

CARB. "Statewide LCFS PM Analysis using 2018 LCFS EA BAU Volumes (March 6, 2018)." Excel Workbook.

CARB. "Air Basin LCFS PM Analysis using 2018 LCFS EA BAU Volumes (March 6, 2018)." Excel Workbook.

## Appendix 6: Health Impacts Methodology

349. Emission Reduction Plan for Ports and Goods Movement in California, Appendix A: Quantification of the Health Impacts and Economic Valuation of Air Pollution from Ports and Goods Movement in California. CARB. March 21, 2006.
350. The influence of location, source, and emission type in estimates of the human health benefits of reducing a ton of air pollution. *Air Qual Atmos Health*. 2009 Sep; 2(3): 169-176. Fann, Neal, Charles M. Fulcher, and Bryan J. Hubbell. 2009.
351. Emission Reduction Plan for Ports and Goods Movement in California, Appendix A: Quantification of the Health Impacts and Economic Valuation of Air Pollution from Ports and Goods Movement in California. CARB. March 21, 2006.
352. Quantitative Health Risk Assessment for Particulate Matter. EPA-452/R-10-005. U.S. EPA. June 2010.
353. Ibid.
354. A two-dimensional interpolation function for irregularly-spaced data. Proceedings of the 1968 ACM National Conference. Pp. 517–524. Shepard, Donald. 1968.
355. A Comparison of Interpolation Methods for Sparse Data: Application to Wind and Concentration Fields. Goodin, William R., Gregory J. McRae, and John H. Seinfeld J. 1979. *Applied Meteor*. 18:761-771.
356. A Comparison among Strategies for Interpolating Maximum and Minimum Daily Air Temperatures. Part II: The Interaction between Number of Guiding Variables and the Type of Interpolation Method. *Journal of Applied Meteorology*. 40, 1075-1084. Jarvis, Claire H. and Neil Stuart. 2001.
357. Areal Interpolation: A Variant of the Traditional Spatial Problem. *Geo-Processing*, 1: 297-312. Goodchild Michael F. and Nina Siu-Ngan Lam. 1980.
358. Areal interpolation and types of data. Chapter 7 in: Fotheringham, Stewart and Peter Rogerson, editors. 1994. *Spatial Analysis and GIS*. London. Taylor and Francis. Flowerdew, Robin and Mick Green. 1994.
359. American Fact Finder. U.S. Census Bureau Webpage, accessed on February 18, 2018. Available at: <https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>.
360. E-1 Population Estimates for Cities, Counties, and the State – January 1, 2016 and 2017. California Department of Finance (CDOF). May 1, 2017.
361. Wide-Ranging On-Line Data for Epidemiologic Research (WONDER) Database. Centers for Disease Control and Prevention (CDC) Webpage, accessed on February 18, 2018. Available at: <https://wonder.cdc.gov/ucd-icd10.html>
362. Appendix J: Methodology for Estimating Ambient Concentration of Particulate Matter from Diesel-Fueled Engine Emissions and Health Benefits Associated with Reductions in Diesel PM Emissions from In-Use On-Road Heavy-Duty Diesel-Fueled Vehicles; Staff Report: Initial Statement of Reasons for Proposed

Rulemaking, Proposed Amendments to the Truck and Bus Regulation, the Drayage Truck Regulation and the Tractor-Trailer Greenhouse Gas Regulation, CARB. October 2010

363. Ambient and Emission Trends of Toxic Air Contaminants in California. *Environ. Sci. Technol.*, 2015, 49 (19), pp 11329–11339). Proper, Ralph, Patrick Wong, Son Bui, Jeff Austin, William Vance, Álvaro Alvarado, Bart Croes, and Dongmin Luo. 2015.
364. California Air Quality Data Available on DVD-ROM (1980-2011). CARB, September 2013. Available at: <https://www.arb.ca.gov/aqd/aqdcd/aqdcd.htm>.
365. *Id.*

## Appendix H      **Analyses Supporting the Addition or Revision of Energy Economy Ratio Values for the Proposed LCFS Amendments**

1. Altoona Bus Research and Testing Center Webpage; PennState Website, accessed on February 14, 2018. Available at: <http://altoonabustest.psu.edu/>
2. Explanatory Footnote.
3. CARB Executive Order A-344-0074-1; Roush Industries Incorporated.
4. CARB Executive Order A-344-0078; Roush Industries Incorporated.
5. Altoona Bus Research and Testing Center Webpage; PennState Website, accessed on February 14, 2018. Available at: <http://altoonabustest.psu.edu/>
6. Partial STURAA Test 10 Year 350,000 Miles Bus from Blue Bird Body Company Model Propane Vision. Report Number: PTI-BT-R1308-P. The Thomas D. Larson Pennsylvania Transportation Institute. July 2013. Available at: <http://altoonabustest.psu.edu/buses/reports/430.pdf?1377522313>.
7. Federal Transit Bus Test. Blue Bird Body Company Model Propane Vision. Report Number: LTI-BT-R1701-P. The Thomas D. Larson Pennsylvania Transportation Institute. July 2017. Available at: <http://altoonabustest.psu.edu/buses/reports/478.pdf?1505843250>.
8. Explanatory Footnote.
9. Alliance of Automobile Manufacturers 2015 Summer Gasoline North American Survey.
10. Explanatory Footnote.
11. Explanatory Footnote.
12. Fuel Properties Comparison, U.S Department of Energy. Alternative Fuels Data Center Webpage, accessed February 15, 2018. Available at: [https://www.afdc.energy.gov/fuels/fuel\\_properties.php](https://www.afdc.energy.gov/fuels/fuel_properties.php)
13. Transport Refrigeration Residual Risk Reduction Airborne Toxic Control Measure (TR4 ATCM) CARB Webpage, accessed on February 16, 2018, Available at <https://www.arb.ca.gov/cc/coldstorage/cold-storage.htm>.
14. Fiscal Year 2015 Pollution Prevention Grant Summaries. Collections and Lists. U.S. Environmental Protection Agency. Office of Chemical Safety and Pollution Prevention. EPA Webpage, accessed on February 17, 2018. Available at: <https://www.epa.gov/p2/fiscal-year-2015-pollution-prevention-grant-summaries#region10>
15. Request for Proposal (RFP) No. 16TTD008 titled Data Collection and Business Case Study for eTRUs. Dated: April 24, 2017. Available at: <https://caleprocure.ca.gov/pages/index.aspx>.



16. CARB, Regulatory Guidance: Transport Refrigeration Units Alternative Technology Compliance Strategies – Electric Standby and Hybrid Electric Systems. June 2013.
17. U.S. EPA motorcycle emissions data. Highway Motorcycle - 1b (50-169cc). <https://www.epa.gov/sites/production/files/2017-03/2018-mc-ctrr.xls>.
18. “Battery Electric Truck and Bus Energy Efficiency Compared to Conventional Diesel Vehicles”. CARB June 2018. Available at: <https://www.arb.ca.gov/msprog/actruck/docs/HDBEVefficiency.pdf>
19. Explanatory Footnote.
20. Altoona Bus Tests (2010 and newer buses) Report Number(s): LTI-BTR1313, LTI-BT1313, PTI-BT-R1211, LTI-BT-R1307, LTI-BT-R1405, LTI-BT-R1406. <http://altoonabustest.psu.edu/buses/>
21. Performance Evaluation of TransPower All-Electric Class 8 On-Road Truck. Johnson. Kent. J. Wavne Miller. And Jiang Yu Xiao. April 2015.
22. In-Use Emissions Testing and Demonstration of Retrofit Technology for Control of On-Road Heavy-Duty Vehicles. Miller, Wayne; Johnson, Kent; Durban, Thomas; Dixit, Poornima. September 2013.
23. Battery Electric Parcel Delivery Truck Testing and Demonstration. California Energy Commission. Gallo, Jean-Baptiste, Jasna Tomic. (CalHEAT). 2013
24. Explanatory Footnote.
25. Explanatory Footnote.
26. Foothill Transit Battery Electric Bus Demonstration Results: Second Report. Eudy and Jeffers. NREL/TP-5400-67698 June 2017.
27. San Diego Airport Parking Company In-Use Shuttle Dataset provided by Lisa McGhee on January 13, 2017.
28. TransPower Electric Yard Tractor Demonstration Project for City of Los Angeles Harbor Department. City of Los Angeles Harbor Department Agreement Number 13-3146; May 29, 2015.
29. TransPower Electric Yard Tractor Demonstration Project for San Joaquin Valley Air Pollution Control District. Technology Advancement Program Agreement Number C-21516-A; July 21, 2015.
30. Hybrid Yard Hostler Demonstration and Commercialization Project, Final Report, Prepared by Calstart, for Port of Long Beach, and the Port of Los Angeles, March 2011.
31. Explanatory Footnote.
32. The National Transit Database (NTD) Federal Transit Administration Database, accessed February 19, 2018. Available at: <https://www.transit.dot.gov/>
33. NREL Fleet DNA Fleet Operations Database, accessed on February 19, 2018. Available at: <https://www.nrel.gov/transportation/fleettest-fleet-dna.html>

34. Dupleep, K.G. Presentation at International Energy Agency workshop. May 2011. Available at: <http://www.iea.org/workshop/work/hdv/duleep.pdf>
35. Federal Transit Bus Test. New Flyer XE40. Thomas D Larson Pennsylvania Transportation Institute. Report Number: LTI-BT-R1405, July 2015.
36. Apostolaki-Iosifidou, Codani, Kempton. Measurement of Power Loss during Electric Vehicle Charging and Discharging. Energy. March 7, 2017.

## Appendix I      Estimating Carbon Intensity Values for the Crude Lookup Table

1. Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Model Version 2.0, El-Houjeiri, H.M., Vafi, K., Masnadi, M.S., Duffy, J., McNally, S., Sleep, S., Pacheco, D., Dashnadi, Z., Orellana, O., MacLean, H., Englander, J., Bergerson, J and A.R. Brandt. March 6, 2018.
2. Oil Production Greenhouse Gas Emissions Estimator (OPGEE) Model Version 2.0, User Guide and Technical Documentation, El-Houjeiri, H.M., Masnadi, M.S., Vafi, K., Duffy, J., and A.R. Brandt, June 5, 2017.
3. LCFS Meetings CARB Webpage, accessed on February 19, 2018. Available at: [http://www.arb.ca.gov/fuels/lcfs/lcfs\\_meetings/lcfs\\_meetings.htm](http://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/lcfs_meetings.htm) (
4. Open source LCA tool for estimating greenhouse gas emissions from crude oil production using field characteristics. *Environmental Science & Technology*. DOI: 10.1021/es304570m. El-Houjeiri, H.M., Brandt, A.R., Duffy, J.E. (2013)
5. Exploring the variation of GHG emissions from conventional oil production using an engineering-based LCA model. American Center for Life Cycle Assessment (ACLCA) LCA XII Conference. Tacoma, WA, September 27th 2012. El-Houjeiri, H.M., A.R. Brandt (2012).
6. Comparing GHG intensity of the oil sands and the average US crude oil. IHS Inc. May (2014)
7. *Upstream Emissions of Fossil Fuel Feedstocks for Transport Fuels Consumed in the European Union*. Authors: Chris Malins, Sebastian Galarza, Anil Baral, Adam Brandt, Hassan El-Houjeiri, Gary Howorth, Tim Grabiell, Drew Kodjak. Washington D.C.: The International Council on Clean Transportation (ICCT). ICCT (2014).
8. OPGEE analysis and comparison to GHGenius. Prepared for Natural Resources Canada, August 19<sup>th</sup>, 2013. O'Connor, D. (2013) (8. OConnor Final Report OPGEE Review rev2.pdf)
9. Uncertainty of Oil Field GHG Emissions Resulting from Information Gaps: A Monte Carlo Approach, *Environmental Science and Technology*, 48, 10511-10518, dx.doi.org/10.1021/es502107s. Vafi, K and A.R. Brandt (2014). (9. Vafi\_and\_Brandt\_2014\_es502107s.pdf)
10. Reproducibility of LCA Models of Crude Oil Production, *Environmental Science and Technology*, Articles ASAP, dx.doi.org/10.1021/es501847p. Vafi, K and A.R. Brandt (2014).
11. MCON Inputs Spreadsheet for Crude Lookup Table, Spreadsheet titled Lookup\_Table\_MCON\_Inputs\_OPGEE\_v2.0.xlsx.

12. Division of Oil, Gas, and Geothermal Resources - Well Search California Department of Conservation, Online Production and Injection Query, accessed on February 19, 2018. Available at: <http://opi.consrv.ca.gov/opi/opi.dll>,
13. Crude production data downloaded as ASCII file and converted to Excel on May 9, 2013 from Bureau of Safety and Environmental Enforcement website. Available at: [http://www.data.bsee.gov/homepg/data\\_center/production/PacificFreeProd.asp](http://www.data.bsee.gov/homepg/data_center/production/PacificFreeProd.asp),
14. California Energy Commission, Spreadsheet titled 2010 MCON Import Results 01-28-12 GDS.
15. MCON Inputs Spreadsheet for 2010 Baseline Crudes, Spreadsheet titled 2010\_Baseline\_MCON\_Inputs\_OPGEE\_v2.0.xlsx.

The following inputs were used and referenced within reference numbers 11 MCON Inputs Spreadsheet for Crude Lookup Table and 15 MCON Inputs Spreadsheet for 2010 Baseline Crudes, of Appendix I.

A. General References for Multiple Crudes:

1. Oil and Gas Journal, 2011 Worldwide Oil Production Survey, 3 Dec 2012.
2. Oil and Gas Journal, 2010 Worldwide Oil Production Survey, 5 Dec 2011.
3. Oil and Gas Journal, 2015 Worldwide Oil Production Survey, 1 Dec 2014.

B. California State:

1. Explanatory Reference: 2015 crude production data copied from the Online Production and Injection Query for State of California, Department of Conservation, Division of Oil, Gas, and Geothermal Resources, <http://opi.consrv.ca.gov/opi/opi.dll>, (accessed May 3, 2017).
2. Explanatory Reference: 2010 crude production data copied from the Online Production and Injection Query for State of California, Department of Conservation, Division of Oil, Gas, and Geothermal Resources, <http://opi.consrv.ca.gov/opi/opi.dll>, (accessed June 6, 2013).
3. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, January 2015.
4. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, February 2015.
5. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, March 2015.
6. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, April 2015.
7. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, May 2015.

8. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, June 2015.
9. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, July 2015.
10. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, August 2015.
11. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, September 2015.
12. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, October 2015.
13. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, November 2015.
14. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, December 2015.
15. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, January 2010.
16. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, February 2010.
17. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, March 2010.
18. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, April 2010.
19. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, May 2010.
20. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, June 2010.
21. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, July 2010.
22. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, August 2010.
23. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, September 2010.
24. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, October 2010.
25. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, November 2010.
26. California Department of Conservation, Monthly Oil and Gas Production and Injection Reports, December 2010.

27. California Department of Conservation, 2009 Annual Report of the State Oil and Gas Supervisor.
28. California Department of Conservation, 2015 Annual Report of the State Oil and Gas Supervisor.
29. California Department of Conservation, California Oil and Gas Fields Vol.1, 1998.
30. California Department of Conservation, California Oil and Gas Fields Vol.2, 1992.
31. California Department of Conservation, California Oil and Gas Fields Vol.3, 1982.
32. Detwiler, Stephanie, California Air Resources Board, 2007 Oil and Gas Industry Survey Results, October 2013.

C. Federal OCS:

1. U.S. Department of the Interior, Estimated Oil and Gas Reserves Pacific Outer Continental Shelf, OCS Report MMS 94-0008, November 1993.
2. Bureau of Safety and Environmental Enforcement website [http://www.data.bsee.gov/homepg/data\\_center/production/PacificFreeProd.aspx](http://www.data.bsee.gov/homepg/data_center/production/PacificFreeProd.aspx) (May 9, 2013). Data downloaded as ASCII file and converted to Excel.
3. Bureau of Safety and Environmental Enforcement website <https://www.data.bsee.gov/Main/PacificProduction.aspx> (April 10, 2017). Data downloaded as ASCII file and converted to Excel.

D. Alaska North Slope (ANS):

1. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, January 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
2. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, February 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
3. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, March 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
4. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, April 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
5. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, May 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
6. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, June 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
7. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, July 2015, <http://doa.alaska.gov/ogc/production/pindex.html>

8. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, August 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
9. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, September 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
10. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, October 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
11. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, November 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
12. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, December 2015, <http://doa.alaska.gov/ogc/production/pindex.html>
13. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, January 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
14. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, February 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
15. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, March 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
16. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, April 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
17. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, May 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
18. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, June 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
19. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, July 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
20. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, August 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
21. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, September 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
22. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, October 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
23. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, November 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
24. Alaska Oil and Gas Conservation Commission, Monthly Production Reports, December 2010, <http://doa.alaska.gov/ogc/production/pindex.html>
25. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Badami Unit – Badami Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)

26. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Colville River Unit – Alpine Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
27. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Colville River Unit – Fiord Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
28. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Colville River Unit – Nanuq Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
29. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Colville River Unit – Qannik Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
30. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Endicott Unit – Eider Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
31. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Endicott Unit – Endicott Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
32. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Endicott Unit – Ivishak Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
33. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Kuparuk River Unit – Kuparuk River Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
34. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Kuparuk River Unit – Meltwater Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
35. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Kuparuk River Unit – Tabasco Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
36. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Kuparuk River Unit – Tarn Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
37. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Kuparuk River Unit – West Sak Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
38. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Milne Point Unit – Kuparuk River Oil Pool,  
[http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)



39. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Milne Point Unit – Schrader Bluff Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
40. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Northstar Unit – Northstar Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
41. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Oooguruk Unit – Oooguruk Kuparuk Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
42. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Oooguruk Unit – Nuiqsut Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
43. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Prudhoe Bay Unit – Aurora Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
44. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Prudhoe Bay Unit – Borealis Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
45. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Prudhoe Bay Unit – Lisburne Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
46. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Prudhoe Bay Unit – Niakuk Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
47. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Prudhoe Bay Unit – Orion Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
48. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Prudhoe Bay Unit – Polaris Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
49. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Prudhoe Bay Unit – Prudhoe Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
50. Alaska Oil and Gas Conservation Commission, Oil and Gas Pools – Statistics Pages, Prudhoe Bay Unit – Pt. McIntyre Oil Pool, [http://doa.alaska.gov/ogc/annual/current/annindex\\_current.html](http://doa.alaska.gov/ogc/annual/current/annindex_current.html), (02/15/2018)
51. Alyeska Pipeline – TAPS – Pipeline Facts, <http://www.alyeska-pipe.com/TAPS/PipelineFacts>, (26 September 2012)
52. Alaska Oil and Gas Conservation Commission, 2015 Gas Disposition Data provided by Jennifer Hunt of the AOGCC.

53. Alaska Oil and Gas Conservation Commission, 2010 Gas Disposition Data provided by Stephen McMains of the AOGCC.

E. United States (except California and Alaska):

1. Rhonda Duey and Nancy Miller, Will Niobrara Turn Up Next Rockies Oil Boom?, E&P Magazine, 1 July 2011, [http://www.epmag.com/Production-Field-Development/Will-Niobrara-Turn-Next-Rockies-Oil-Boom\\_85275](http://www.epmag.com/Production-Field-Development/Will-Niobrara-Turn-Next-Rockies-Oil-Boom_85275), (1 March 2013)
2. Colorado Oil and Gas Conservation Commission, COGIS - County Monthly Production, <http://cogcc.state.co.us/data.html#/cogis>, (Accessed Apr 27, 2017)
3. Offshore Technology – Projects, Mars Oil and Gas Field Project, Gulf of Mexico, <http://www.offshore-technology.com/projects/mars/>, February 15, 2018
4. Shell Global, Mars B, <https://www.shell.com/about-us/major-projects/mars-b.html>, (February 15, 2018)
5. BP Crude oil & refined products, Mars, <https://www.bp.com/en/global/trading/crude-oil-and-refined-products/crudes/americas/mars.html>, (February 13, 2018).
6. New Mexico Oil Conservation Division, Natural Gas and Oil Production, <https://wwwapps.emnrd.state.nm.us/ocd/ocdpermitting/Reporting/Production/ExpandedProductionInjectionSummaryReport.aspx>, (accessed April 30, 2017)
7. North Dakota Department of Mineral Resources, Spreadsheet titled 2011 North Dakota Production and Injection Data, received by email on March 1, 2013.
8. North Dakota Department of Mineral Resources, Spreadsheet titled 2015 North Dakota Production and Injection Data, received by email on May 9, 2017.
9. Argus Media, Argus Bakken crude assessments, Argus Media Ltd., 2011.
10. North Dakota Department of Mineral Resources, Presentation dated January 25, 2012, slide 36.
11. North Dakota Department of Mineral Resources, ND Monthly Oil Production Statistics, <https://www.dmr.nd.gov/oilgas/stats/historicaloilprodstats.pdf>
12. North Dakota Department of Mineral Resources, Historical monthly gas production and sales statistics, <https://www.dmr.nd.gov/oilgas/stats/statisticsvw.asp>, (accessed May 1, 2017)
13. Railroad Commission of Texas, Oil Production and Well Counts, <http://www.rrc.state.tx.us/oil-gas/research-and-statistics/production-data/historical-production-data/crude-oil-production-and-well-counts-since-1935/>, (February 13, 2018).

14. Wikipedia, West Texas Intermediate, [http://en.wikipedia.org/wiki/West\\_Texas\\_Intermediate](http://en.wikipedia.org/wiki/West_Texas_Intermediate), (July 16, 2013).
15. Railroad Commission of Texas, Annual Summary of Texas Natural Gas 2015, May 2015.
16. Railroad Commission of Texas, Online System, H10 Data Queries, <http://www.rrc.state.tx.us/about-us/resource-center/research/online-research-queries/>, (May 10, 2017).
17. Railroad Commission of Texas, Online System, Production Data Query, <http://www.rrc.state.tx.us/about-us/resource-center/research/online-research-queries/>, (May 10, 2017).
18. AAPG Wiki, Covenant field, [http://wiki.aapg.org/Covenant\\_field](http://wiki.aapg.org/Covenant_field), (February 13, 2018).
19. Chidsey T. and Sprinkel D., Utah Geological Society, Major Oil Plays in Utah and Vicinity, March 2007, <https://geology.utah.gov/major-oil-plays-in-utah-and-vicinity/>, (March 1, 2013).
20. Utah Division of Oil, Gas, and Mining, Production Report by Field, 2015, <https://oilgas.ogm.utah.gov/oilgasweb/statistics/oil-prod-by-fld.xhtml>, (April 27, 2017).
21. Utah Division of Oil Gas and Mining, Utah Oil Production by Year, <https://oilgas.ogm.utah.gov/oilgasweb/statistics/oil-prod-by-year.xhtml>, (April 27, 2017).
22. Utah Division of Oil Gas and Mining, Well Counts, <https://oilgas.ogm.utah.gov/oilgasweb/statistics/well-counts.xhtml>, (April 27, 2017).
23. Wyoming Oil and Gas Conservation Commission, Production for Year 2015, <http://wogcc.state.wy.us/>, (accessed April 28, 2017).
24. U.S. Energy Information Administration, Petroleum and Other Liquids, Crude Oil Production, 2011, [http://www.eia.gov/dnav/pet/pet\\_crd\\_crpdn\\_adc\\_mbbldpd\\_a.htm](http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbldpd_a.htm), (May 21, 2013)
25. U.S. Energy Information Administration, Natural Gas, Natural Gas Gross Withdrawals and Production, Gross Withdrawals from Oil Wells, 2011, [http://www.eia.gov/dnav/ng/ng\\_prod\\_sum\\_a\\_EPG0\\_FGO\\_mmcf\\_a.htm](http://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_FGO_mmcf_a.htm), (May 21, 2013)
26. U.S. Energy Information Administration, Natural Gas, Natural Gas Gross Withdrawals and Production, Vented and Flared, 2011, [http://www.eia.gov/dnav/ng/ng\\_prod\\_sum\\_a\\_epg0\\_vgv\\_mmcf\\_a.htm](http://www.eia.gov/dnav/ng/ng_prod_sum_a_epg0_vgv_mmcf_a.htm), (May 21, 2013)
27. U.S. Energy Information Administration, Natural Gas, Natural Gas Gross Withdrawals and Production, Repressuring, 2011,

- [http://www.eia.gov/dnav/ng/ng\\_prod\\_sum\\_a\\_EPG0\\_VGQ\\_mmcf\\_a.htm](http://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGQ_mmcf_a.htm) ,  
(May 21, 2013)
28. U.S. Energy Information Administration, Petroleum and Other Liquids, Crude Oil Production, 2015,  
[http://www.eia.gov/dnav/pet/pet\\_crd\\_crpdn\\_adc\\_mbbldpd\\_a.htm](http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbldpd_a.htm), (April 27, 2017)
  29. U.S. Energy Information Administration, Natural Gas, Natural Gas Gross Withdrawals and Production, Gross Withdrawals from Oil Wells, 2015,  
[http://www.eia.gov/dnav/ng/ng\\_prod\\_sum\\_a\\_EPG0\\_FGO\\_mmcf\\_a.htm](http://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_FGO_mmcf_a.htm), (April 27, 2017)
  30. U.S. Energy Information Administration, Natural Gas, Natural Gas Gross Withdrawals and Production, Vented and Flared, 2015,  
[http://www.eia.gov/dnav/ng/ng\\_prod\\_sum\\_a\\_epg0\\_vgv\\_mmcf\\_a.htm](http://www.eia.gov/dnav/ng/ng_prod_sum_a_epg0_vgv_mmcf_a.htm), (April 27, 2017)
  31. U.S. Energy Information Administration, Natural Gas, Natural Gas Gross Withdrawals and Production, Repressuring, 2015,  
[http://www.eia.gov/dnav/ng/ng\\_prod\\_sum\\_a\\_EPG0\\_VGQ\\_mmcf\\_a.htm](http://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGQ_mmcf_a.htm) ,  
(April 27, 2017)

F. Algeria:

1. Middle East Economic Survey (MEES) archives, Andarko Plans to Lift Hassi Berkine Crude in June, 27 April 1998,  
<http://archives.mees.com/issues/687/articles/27344>, (November 15, 2012).
2. Maersk Oil, Saharan Blend Crude Oil, <http://www.maerskoil.com/about-us/sales/oil-sales-algeria>, (February 13, 2018).
3. Energy Information Administration, Country Analysis Briefs, Algeria,  
<https://www.eia.gov/beta/international/analysis.cfm?iso=DZA>, 11 March 2016.

G. Angola:

1. Offshore Magazine, Cabinda waterflood program one of the world's largest, vol. 60, issue 2, <http://www.offshore-mag.com/articles/print/volume-60/issue-2/news/exploration/cabinda-waterflood-program-one-of-the-worlds-largest.html>, (November 15, 2012).
2. Chevron Crude Oil Marketing, Cabinda (Angola),  
<http://crudemarketing.chevron.com/crude/african/cabinda.aspx>, (October 10, 2012).
3. The Washington Post, International Spotlight: Angola, Cabinda: Oil – Block Buster, <http://www.washingtonpost.com/wp-adv/specialsales/spotlight/angola/article12.html>, (April 22, 2013).

4. SubSealQ – Offshore Field Development Projects, Mafumeira, [http://www.subseaiq.com/data/Project.aspx?project\\_id=451](http://www.subseaiq.com/data/Project.aspx?project_id=451), (November 16, 2012).
5. One Petro – Document Preview, Society of Petroleum Engineers, Utilization of Sand Control and Mechanical Profile Control in Numbi Field Water Injection Wells, <https://www.onepetro.org/conference-paper/SPE-54746-MS>, (November 16, 2012).
6. Alexander’s Gas and Oil Connections, Angolan North N’Dola gives first oil, 26 June 1997, <http://www.gasandoil.com/news/1997/06/cna72606>, (November 16, 2012).
7. Offshore Magazine, First condensate production from the Sanha field, <http://www.offshore-mag.com/articles/2005/03/first-condensate-production-from-the-sanha-field.html>, (November 16, 2012).
8. Total – Exploration and Production, Dalia – The Conquest of the Deep Offshore, February 2007.
9. Offshore Technology – Projects, Dalia Field – Angola, <http://www.offshore-technology.com/projects/dalia/>, (July 25, 2012).
10. Statoil – Crude Summary Report, Dalia, <https://www.statoil.com/en/what-we-do/crude-oil-and-condensate-assays.html>, May 2013.
11. Offshore Technology – Projects, Gimboa Field, <http://www.offshore-technology.com/projects/gimboa/>, (January 15, 2013).
12. Statoil – Crude Oil Assays, Gimboa, (January 15, 2013).
13. Offshore Technology – Projects, Girassol FPSO, Luanda, Angola, <http://www.offshore-technology.com/projects/girassol/>, (July 25, 2012).
14. Total – Exploration and Production, Girassol – A Stepping Stone for the Industry, May 2003.
15. Statoil – Crude Summary Report, Girassol, <https://www.statoil.com/en/what-we-do/crude-oil-and-condensate-assays.html>, February 2015.
16. BP, Plutonio – Crude Oil from Angola, January 2010, [http://www.bp.com/liveassets/bp\\_internet/bp\\_crudes/bp\\_crudes\\_global/STAGING/local\\_assets/downloads\\_pdfs/Plutonio\\_marketing\\_brochure\\_2010.pdf](http://www.bp.com/liveassets/bp_internet/bp_crudes/bp_crudes_global/STAGING/local_assets/downloads_pdfs/Plutonio_marketing_brochure_2010.pdf).
17. Offshore Magazine, BP’s Greater Plutonio cluster development may set stage for more, vol. 66, issue 2, <http://www.offshore-mag.com/articles/print/volume-66/issue-2/west-africa/bps-quos-greater-plutonio-cluster-development-may-set-stage-for-more.html>, (November 27, 2012).
18. Offshore Technology – Projects, Greater Plutonio - Block 18, [http://www.offshore-technology.com/projects/greater\\_plutonio/](http://www.offshore-technology.com/projects/greater_plutonio/), (November 21, 2012).

19. ExxonMobil – Worldwide operations-Crude Trading, Hungo Blend, <http://corporate.exxonmobil.com/en/company/worldwide-operations/crude-oils/hungo-blend>, (February 13, 2018).
20. Fluor – Projects, Kizomba A FPSO, <http://www.fluor.com/projects/Pages/ProjectInfoPage.aspx?prjid=93>, (November 15, 2012).
21. Statoil – Crude Summary Report, Hungo Blend, <https://www.statoil.com/en/what-we-do/crude-oil-and-condensate-assays.html>, January 2016.
22. ExxonMobil – Worldwide operations-Crude Trading, Kissanje Blend, <http://corporate.exxonmobil.com/en/company/worldwide-operations/crude-oils/kissanje-blend>, (February 13, 2018).
23. Oil and Gas Journal, Kizomba B attains production capacity early, 10 October 2005, <http://www.ogj.com/articles/print/volume-103/issue-38/special-report/kizomba-b-attains-production-capacity-early.html>, (November 15, 2012).
24. SBM Offshore, FPSO Mondo – ExxonMobil – Angola, [http://www.sbmoffshore.com/wp-content/themes/sbm/swfs/maps/factfile/FPSO\\_MONDO\\_ExxonMobil\\_Angola.pdf](http://www.sbmoffshore.com/wp-content/themes/sbm/swfs/maps/factfile/FPSO_MONDO_ExxonMobil_Angola.pdf), (November 15, 2012).
25. ExxonMobil – Worldwide operations-Crude Trading, Mondo, <http://corporate.exxonmobil.com/en/company/worldwide-operations/crude-oils/mondo>, (February 13, 2018).
26. Offshore Technology – Projects, Kizomba Offshore Field Deepwater Project, <http://www.offshore-technology.com/projects/kizomba/>, (November 21, 2012).
27. BP Crude oil & refined products, Mondo, [https://www.bp.com/en/global/trading/crude-oil-and-refined-products/crudes/west\\_africa/mondo.html](https://www.bp.com/en/global/trading/crude-oil-and-refined-products/crudes/west_africa/mondo.html), (February 13, 2018).
28. Platts, Methodology and Specifications Guide – Crude Oil, October 2012, page 8, [http://www.platts.com/IM.Platts.Content/methodologyreferences/methodology\\_specs/crudeoilspecs.pdf](http://www.platts.com/IM.Platts.Content/methodologyreferences/methodology_specs/crudeoilspecs.pdf), (November 16, 2012).
29. Chevron – Crude Oil Marketing, Nemba (Angola), 2011, <http://crudemarketing.chevron.com/crude/african/nemba.aspx>, (October 17, 2012).
30. Society of Petroleum Engineers, Journal of Petroleum Technology, Nemba Field Development: A Phased Approach, December 1997, 1346-1348, [http://www.spe.org/jpt/print/archives/1997/12/97December\\_RM.pdf](http://www.spe.org/jpt/print/archives/1997/12/97December_RM.pdf), (November 16, 2012).

31. ExxonMobil – Worldwide operations-Crude Trading, Pazflor, <http://corporate.exxonmobil.com/en/company/worldwide-operations/crude-oils/pazflor>, (February 13, 2018).
32. Ship Technology – Projects, Pazflor FPSO Vessel, <http://www.ship-technology.com/projects/pazflor-fps/>, (January 15, 2013).
33. BP Crude oil & refined products, Pazflor, [https://www.bp.com/en/global/trading/crude-oil-and-refined-products/crudes/west\\_africa/pazflor.html](https://www.bp.com/en/global/trading/crude-oil-and-refined-products/crudes/west_africa/pazflor.html), (February 13, 2018).
34. Offshore Technology – Projects, West Hub Development Project, <http://www.offshore-technology.com/projects/west-hub-development-project>, (February 13, 2018).
35. Eni, Angola block 15/06 west hub project, [https://www.eni.com/docs/en\\_IT/enicom/publications-archive/publications/brochures-booklets/countries/angola\\_bassa\\_ENG\\_singole.pdf](https://www.eni.com/docs/en_IT/enicom/publications-archive/publications/brochures-booklets/countries/angola_bassa_ENG_singole.pdf), July 2014

#### H. Argentina:

1. National Oil Company, Crude Oil Properties and Specifications, [http://www.sinosi.com/oil/english/yyou\\_1.asp](http://www.sinosi.com/oil/english/yyou_1.asp), (September 24, 2012).
2. Zeetech Engineering and Management – Project Profile, Total Austral Hidra Field Development, <http://www.zeetechengineering.com/files/PDF/ETPM-Total%20Austral%20Hidra%20Field%20Development%20-%201989-88910ZT.pdf>, (July 23, 2012).
3. Chevron – Crude Oil Marketing, Medanito, 2011, [http://crudemarketing.chevron.com/crude/latin\\_american/medanito.aspx](http://crudemarketing.chevron.com/crude/latin_american/medanito.aspx), (October 17, 2012).

#### I. Australia:

1. Offshore Technology – Projects, Enfield Oil Field, <http://www.offshore-technology.com/projects/enfield-oil-field-western-australia/>, (June 5, 2014).
2. BHP Billiton, Pyrenees Oil Field Development, June 2007, <http://www.gdc.wa.gov.au/uploads/files/pyreneesOilFieldBrochure.pdf>, (May 21, 2012).
3. Offshore Technology – Projects, Pyrenees Project, Australia, <http://www.offshore-technology.com/projects/pyreneesproject/>, (July 25, 2012).
4. Intertek – Crude Oil Assay, Pyrenees Crude, 16 September 2011, <http://www.bhpbilliton.com/home/businesses/Documents/Pyrenees%20Post%20Production%20Assay%20Report%20May102010.pdf>, (April 23, 2013).
5. Offshore Technology – Projects, Stybarrow Oil Field, <http://www.offshore-technology.com/projects/stybarrow/>, (October 11, 2012).

6. PRLog (Press Release), Stybarrow Project, Australia, Commercial Asset Valuation and Forecast to 2016, 24 August 2010, <http://www.prlog.org/10880145-stybarrow-project-australia-commercial-asset-valuation-and-forecast-to-2016-published.html>, (November 16, 2012).
7. Offshore Technology – Projects, Van Gogh Oil Project, Exmouth Sub-Basin, [http://www.offshore-technology.com/projects/apache\\_vangogh/](http://www.offshore-technology.com/projects/apache_vangogh/), (November 16, 2012).
8. Bell S., Rigzone, Apache's Van Gogh Oil Field Resumes Production, 8 March 2011, [http://www.rigzone.com/news/article.asp?a\\_id=104908&hmpn=1](http://www.rigzone.com/news/article.asp?a_id=104908&hmpn=1), (November 21, 2012).
9. Offshore Technology – Projects, Vincent Field, <http://www.offshore-technology.com/projects/vincent-field/>, (October 11, 2012).

#### J. Azerbaijan:

1. Offshore Technology – Projects, Azeri – Chirag - Gunashli Oilfield, <http://www.offshore-technology.com/projects/acg/>, (October 11, 2012).
2. Chevron – Crude Oil Marketing, Azeri, 2011, [http://crudemarketing.chevron.com/crude/central\\_asian/azeri.aspx](http://crudemarketing.chevron.com/crude/central_asian/azeri.aspx), (October 17, 2012).
3. BP, BP Azerbaijan Business Update 2015 year-end results, 29 February 2016, [https://www.bp.com/en\\_az/caspian/press/businessupdates/2015-year-end-results.html](https://www.bp.com/en_az/caspian/press/businessupdates/2015-year-end-results.html), (February 14, 2018).
4. Energy Information Administration, Country Analysis Briefs, Azerbaijan, <https://www.eia.gov/beta/international/analysis.cfm?iso=AZE>, June 24, 2016.

#### K. Brazil:

1. Loureiro R., Patrocinio B., Barbosa B., Bolatti N., Albacora Leste Field Development Project, Offshore Technology Conference 2006, OTC 17925.
2. Offshore Technology – Projects, Bijupira and Salema Fields, <http://www.offshore-technology.com/projects/bijupira/>, (November 14, 2012).
3. Modec – Floating Production Solutions, FPSO Fluminense, 12 August 2003, [http://www.modec.com/fps/fps\\_fso/projects/bijupira.html](http://www.modec.com/fps/fps_fso/projects/bijupira.html), (November 20, 2012).
4. Rigzone, Shell begins production from Bijupira-Salema fields, 14 August 2003, [http://www.rigzone.com/news/article.asp?a\\_id=7928](http://www.rigzone.com/news/article.asp?a_id=7928), (November 20, 2012).
5. Offshore Technology – Projects, Frade Field Gas and Oil Project, Campos Basin, Brazil, <http://www.offshore-technology.com/projects/fradefieldcamposbasi/>, (July 25, 2012).



6. SubSealQ – Offshore Field Development Projects, Frade, September 13, 2013, [http://subseaiq.com/data/Project.aspx?project\\_id=313](http://subseaiq.com/data/Project.aspx?project_id=313), (February 14, 2018).
7. SubSealQ – Offshore Field Development Projects, Jubarte, 6 October 2010, [http://subseaiq.com/data/Project.aspx?project\\_id=764&AspxAutoDetectCookieSupport=1](http://subseaiq.com/data/Project.aspx?project_id=764&AspxAutoDetectCookieSupport=1), (January 15, 2013).
8. Rigzone, Petrobras Kick's Off Production in Jubarte Field's Pre-salt Layer, 2 September 2008, [http://www.rigzone.com/news/article.asp?a\\_id=66147](http://www.rigzone.com/news/article.asp?a_id=66147), (February 8, 2013).
9. EPC Engineer, Petrobras Started Oil Production from Jubarte Platform-Services Co., 21 December 2010, <http://www.epcengineer.com/news/post/2774/petrobras-started-oil-production-from-jubarte-platform-services-co>, (January 15, 2013).
10. SubSealQ – Offshore Field Development Projects, Lula (Tupi), March 5, 2015, [http://subseaiq.com/data/Project.aspx?project\\_id=274](http://subseaiq.com/data/Project.aspx?project_id=274), (February 14, 2018).
11. Fick J., RigZone, Petrobras Pumps First Crude from Massive Tupi Field Offshore Brazil, 1 May 2009, [http://www.rigzone.com/news/article.asp?a\\_id=75679](http://www.rigzone.com/news/article.asp?a_id=75679), (January 16, 2013).
12. BG Group – Crude Oil Assays, Lula, 2012, (January 16, 2013).
13. Offshore Technology – Projects, Marlim Oil Field, Brazil, <http://www.offshore-technology.com/projects/marlimpetro/>, (July 25, 2012).
14. Offshore Technology – Projects, Marlim Sul, Brazil, <http://www.offshore-technology.com/projects/marlim/>, (July 25, 2012).
15. Reuters, Brazil Petrobras to boost output at Marlim Sul, 2 June 2011, <http://uk.reuters.com/article/2011/06/02/petrobras-platform-idUKN0227875420110602>, (January 18, 2013).
16. SubSealQ – Offshore Field Development Projects, Marlim Sul (South), 5 January 2012, [http://subseaiq.com/data/Project.aspx?project\\_id=371](http://subseaiq.com/data/Project.aspx?project_id=371), (January 18, 2013).
17. Offshore Technology – Projects, Parque das Conchas (BC-10), Brazil, <http://www.offshore-technology.com/projects/bc-10/>, (July 25, 2012).
18. Parshall J., Brazil Parque das Conchas Project Sets Subsea Separation, Pumping Milestone, Journal of Petroleum Technology, September 2009, pages 38-42.
19. SubSealQ – Offshore Field Development Projects, Parque das Conchas (BC-10), March 25, 2014, [http://www.subseaiq.com/data/Project.aspx?project\\_id=365](http://www.subseaiq.com/data/Project.aspx?project_id=365), (February 14, 2018).

20. Rigzone, Devon Begins Production at Polvo Field Offshore Brazil, 30 July 2007, [http://www.rigzone.com/news/article.asp?a\\_id=48311](http://www.rigzone.com/news/article.asp?a_id=48311), (July 25, 2012).
21. Wortheim P., Devon breaks new ground at Polvo, Offshore Magazine, 2012, volume 68, issue 3, <http://www.offshore-mag.com/articles/print/volume-68/issue-3/production-operations/devon-breaks-new-ground-at-polvo.html>, (November 27, 2012).
22. A Barrel Full, Polvo Oil Field, January 9, 2017, <http://abarrelfull.wikidot.com/polvo-oil-field>, (February 14, 2018).
23. SubSeaIQ – Offshore Field Development Projects, Roncador, October 11, 2013, [http://subseaiq.com/data/Project.aspx?project\\_id=348](http://subseaiq.com/data/Project.aspx?project_id=348), (February 14, 2018).
24. Offshore Technology – Projects, Roncador, <http://www.offshore-technology.com/projects/roncador/>, (October 11, 2012).
25. Offshore Technology – Projects, Guara Oilfield, Santos Basin, Brazil, <http://www.offshore-technology.com/projects/guaraoilfield/>, (January 16, 2013).
26. SubSeaIQ – Offshore Field Development Projects, Sapinhua (Guara), November 21, 2014, [http://www.subseaiq.com/data/Project.aspx?project\\_id=536](http://www.subseaiq.com/data/Project.aspx?project_id=536), (February 14, 2018).
27. Dupre R., Rigzone, Petrobras Starts Up Production at Sapinhua, 8 January 2013, [http://www.rigzone.com/news/oil\\_gas/a/123291/Petrobras\\_Starts\\_Up\\_Production\\_at\\_Sapinhua](http://www.rigzone.com/news/oil_gas/a/123291/Petrobras_Starts_Up_Production_at_Sapinhua), (January 16, 2013).

L. Cameroon:

1. A Barrel Full, Lokele Crude Oil, 2 May 2012, <http://abarrelfull.wikidot.com/lokele-crude-oil>, (July 25, 2012).

M. Canada:

1. Alberta Energy Regulator, ST60B-2016: Upstream Petroleum Industry Flaring and Venting Report, 2015, February 2017.
2. Energy Resources Conservation Board, ST60B-2011: Upstream Petroleum Industry Flaring and Venting Report, 2010, September 2011.
3. Energy Resources Conservation Board, ST60B-2012: Upstream Petroleum Industry Flaring and Venting Report, 2011, September 2012.
4. Energy Resources Conservation Board, ST98-2016: Alberta's Energy Reserves 2015 and Supply/Demand Outlook 2016-2025, June 2016.

5. Kinder Morgan – Canada, Trans Mountain Pipeline System, <http://www.kindermorgan.com/business/canada/transmountain.cfm>, (July 25, 2012).
6. Jacobs Consultancy, EU Pathway Study: Lifecycle Assessment of Crude Oils in a European Context, March 2012.
7. Crude Monitor – Canadian Crude Quality Monitoring Program. Access Western Blend, 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=AWB>, (February 14, 2018).
8. Devon Canada Corporation, 2016 Subsurface Performance Presentation – Jackfish SAGD Project, October 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016AthabascaDevonJackfishSAGD10097.pdf>.
9. MEG Energy, Christina Lake Regional Project – 2015/2016 Performance Presentation, September 6 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016MEGChristinaLakeSAGD10773.pdf>.
10. MEG Energy, Operations – Christina Lake Project, <http://www.megenergy.com/operations/christina-lake-project>, (July 17, 2014).
11. Crude Monitor – Canadian Crude Quality Monitoring Program. Albian Heavy Synthetic (AHS), 2017, <http://www.crudemonitor.ca/crudes/index.php?acr=AHS>, (February 14, 2018).
12. Shell Canada, Scotford Upgrader, [https://www.shell.ca/en\\_ca/about-us/projects-and-sites/scotford.html](https://www.shell.ca/en_ca/about-us/projects-and-sites/scotford.html), (February 14, 2018).
13. Imperial Oil, Cold Lake Approvals – Annual Performance Review, 2011, <http://www.aer.ca/data-and-publications/activity-and-data/in-situ-performance-presentations>.
14. Imperial Oil, Cold Lake Approvals – 2016 Annual Performance Review, 2016, <https://www.aer.ca/data-and-publications/activity-and-data/in-situ-performance-presentations>.
15. Crude Monitor – Canadian Crude Quality Monitoring Program, Cold Lake (CL), 2017, <http://www.crudemonitor.ca/crudes/index.php?acr=CL>, (February 14, 2018).
16. Crude Monitor – Canadian Crude Quality Monitoring Program, Peace River Heavy (PH), 2013, <http://www.crudemonitor.ca/crudes/index.php?acr=PH>, (February 14, 2018).
17. Shell Canada, Peace River In Situ Oil Sands Progress Report, 16 February 2017, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016PeaceRiverShellPeaceRiverSAGD8143.pdf>.
18. Crude Monitor – Canadian Crude Quality Monitoring Program, Shell Synthetic Light (SSX), 2014, <http://www.crudemonitor.ca/crudes/index.php?acr=SSX>, (February 14, 2018).

19. Crude Monitor – Canadian Crude Quality Monitoring Program, Borealis Heavy Blend (BHB), 2017, <http://www.crudemonitor.ca/crudes/index.php?acr=BHB>, (February 14, 2018).
20. Crude Monitor – Canadian Crude Quality Monitoring Program, Suncor Synthetic A (OSA), 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=OSA>, (February 14, 2018).
21. Suncor Energy, Suncor MacKay River: 2011 ERCB Performance Presentation, 30 November 2011, <http://www.aer.ca/data-and-publications/activity-and-data/in-situ-performance-presentations>.
22. Suncor Energy, Suncor MacKay River: 2016 AER Performance Presentation, 25 November 2016 <https://www.aer.ca/documents/oilsands/insitu-presentations/2016AthabascaSuncorMacKaySAGD8668.pdf>.
23. Suncor Energy, Suncor Firebag: 2011 ERCB Performance Presentation, 5 May 2011, <http://www.aer.ca/data-and-publications/activity-and-data/in-situ-performance-presentations>.
24. Suncor Energy, Suncor Firebag: 2016 ERCB Performance Presentation, 27 June 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016AthabascaSuncorFirebagSAGD8870.pdf>.
25. Crude Monitor – Canadian Crude Quality Monitoring Program, Surmont Heavy Blend (SHB), 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=SHB>, (February 14, 2018).
26. ConocoPhillips, Surmont Synbit – Safety Data Sheet, 3 April 2012.
27. ConocoPhillips and Total, Annual Surmont SAGD Performance Review, 6 April 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016AthabascaConocoSurmontSAGD94609426.pdf>.
28. Crude Monitor – Canadian Crude Quality Monitoring Program, Syncrude Synthetic (SYN), 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=SYN>, (February 14, 2018).
29. Crude Monitor – Canadian Crude Quality Monitoring Program, Wabasca Heavy (WH), 2017, <http://www.crudemonitor.ca/crudes/index.php?acr=WH>, (February 14, 2018).
30. Cenovus, Performance Review of In Situ Oil Sands Scheme Approval 9404T, 20 May 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016AthabascaCenovusBrintnellER9404.pdf>.
31. Crude Monitor – Canadian Crude Quality Monitoring Program, Christina Dilbit Blend, 2017, <http://www.crudemonitor.ca/crudes/index.php?acr=CDB>, (February 14, 2018).
32. Cenovus Energy, Cenovus Christina Lake In-situ Oil Sands Scheme 2015-2016 Update, 15 June 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016AthabascaCenovusChristinaSAGD8591.pdf>.

33. Crude Monitor – Canadian Crude Quality Monitoring Program, CNRL Light Sweet Synthetic (CNS), 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=CNS>, (February 14, 2018).
34. Crude Monitor – Canadian Crude Quality Monitoring Program, Hardisty Synthetic Crude (HSC), 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=HSC>, (February 14, 2018).
35. Crude Monitor – Canadian Crude Quality Monitoring Program, Husky Synthetic Blend, 2017, <http://www.crudemonitor.ca/crudes/index.php?acr=HSB>, (February 14, 2018).
36. Husky Energy, Tucker Thermal Project Annual Performance Presentation, 23 May 2013, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016ColdLakeHuskyTuckerSAGD9835.pdf>.
37. Raymond James, Canada Research, Husky Energy Inc., 30 Oct 2012, pages 12 – 13.
38. Crude Monitor – Canadian Crude Quality Monitoring Program, Long Lake Heavy (PSH), 2017, <http://www.crudemonitor.ca/crudes/index.php?acr=PSH>, (February 14, 2018).
39. Nexen, Long Lake 2016 – Subsurface Performance Presentation, 15 November 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016AthabascaNexenLongLakeSAGD9485.pdf>.
40. Crude Monitor – Canadian Crude Quality Monitoring Program, Mackay River (MKH), 2007, <http://crudemonitor.ca/crudes/index.php?acr=mkh>, (February 14, 2018).
41. Crude Monitor – Canadian Crude Quality Monitoring Program, Premium Albion Synthetic (PAS), 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=PAS>, (February 14, 2018).
42. Crude Monitor – Canadian Crude Quality Monitoring Program, Premium Synthetic (PSY), 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=PSY>, (February 14, 2018).
43. Crude Monitor – Canadian Crude Quality Monitoring Program, Leismer Corner Blend (LCB), 2017, <http://www.crudemonitor.ca/crudes/index.php?acr=LCB>, (February 14, 2018).
44. Statoil Canada, Leismer SAGD Project, 10 March 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016AthabascaStatoilLeismerSAGD10935-Pre.zip>.
45. Crude Monitor – Canadian Crude Quality Monitoring Program, Synbit Blend (SYB), 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=SYB>, (February 14, 2018).
46. Crude Monitor – Canadian Crude Quality Monitoring Program, Synthetic Sweet Blend (SYN), 2018, <http://www.crudemonitor.ca/crudes/index.php?acr=SYN>, (February 14, 2018).

47. Crude Monitor – Canadian Crude Quality Monitoring Program, Western Canadian Select (WCS), 2017, <http://www.crudemonitor.ca/crudes/index.php?acr=WCS>, (February 14, 2018).
48. Cenovus Energy, Western Canadian Select (WCS) fact sheet, <http://www.cenovus.com/operations/doing-business-with-us/marketing/western-canadian-select-fact-sheet.html>, (August 21, 2014).
49. Cenovus Energy, Cenovus Foster Creek In-situ Oilsands Scheme Update for 2015, 31 May 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016AthabascaCenovusFosterCreekSAGD8623.pdf>.
50. Canadian Natural, Primrose, Wolf Lake, and Burnt Lake 2014 Annual Presentation to the AER, January 2016, <https://www.aer.ca/documents/oilsands/insitu-presentations/2016ColdLakeCNRLPAWCSS9140.pdf>.

N. Chad:

1. ExxonMobil – Worldwide operations-Crude Trading, Doba Blend, <http://corporate.exxonmobil.com/en/company/worldwide-operations/crude-oils/doba-blend>, (February 14, 2018).

O. Colombia:

1. Osorio G., Ecopetrol, Heavy Oil and Mature Oil Fields Development in Colombia, Global Petroleum Show, Calgary, Canada, 11 June 2008.
2. Osorio G., Ecopetrol, Heavy Oil Projects in Colombia, XVII Annual Latin American Energy Conference, 13 May 2008, <https://www.iamericas.org/documents/ljc08/Gabriel%20Osorio.pdf>, (December 5, 2012).
3. Gran Tierra – Gran Tierra Energy Inc. Announces Strategic US\$525 Million Acquisition of PetroLatina Energy Ltd. in Colombia, <http://grantierra.mwnewsroom.com/press-releases/gran-tierra-energy-inc-announces-strategic-us525-million-acquisition-of-petrola-tsx-qte-201607011061339001>, (February 14, 2018).
4. A Barrel Full, Cano Limon Crude, 8 April 2012, <http://abarrelfull.wikidot.com/cano-limon-crude>, (October 11, 2012).
5. Energy Information Administration – Country Analysis Briefs, Colombia, 29 June 2016, <https://www.eia.gov/beta/international/analysis.cfm?iso=COL>
6. PR Newswire, The Castilla Field Reached a Record Production of 100,000 Barrels of Crude per Day, 15 June 2012, <http://www.prnewswire.com/news-releases/the-castilla-field-reached-a-record-production-of-100000-barrels-of-crude-per-day-96373309.html>, (July 25, 2012).

7. One Petro – Document Preview, Society of Petroleum Engineers, Horizontal Well Placement Optimization for Heavy Oil Production in Girasol Field, 2010, <https://www.onepetro.org/conference-paper/SPE-132884-MS>, (December 5, 2012).
8. Moritis G., Oil and Gas Journal, Special Report: EOR/Heavy Oil Survey: CO<sub>2</sub> miscible, steam dominate enhance oil recovery processes, 19 April 2010, <http://www.ogj.com/articles/print/volume-108/issue-14/technology/special-report-eor.html>, (February 26, 2013).
9. Rigzone, Ecopetrol: Rubiales, Quifa Crude Treatment Facilities Begin Ops, 18, November 2010, [http://www.rigzone.com/news/article.asp?a\\_id=101376](http://www.rigzone.com/news/article.asp?a_id=101376), (February 26, 2013).
10. Ecopetrol, South Blend, 2012, <http://www.ecopetrol.com.co/english/contenido.aspx?catID=293&conID=40538>, (October 11, 2012).
11. Wikipedia, Transandino Pipeline, 6 October 2012, [http://en.wikipedia.org/wiki/Transandino\\_pipeline](http://en.wikipedia.org/wiki/Transandino_pipeline), (January 17, 2013).
12. TOTSA – Total Oil Trading SA, Crude Assays – Latin America, 2003, [http://www.totsa.com/pub/crude/index2.php?expand=4&iback=4&rub=11&image=latin\\_america](http://www.totsa.com/pub/crude/index2.php?expand=4&iback=4&rub=11&image=latin_america), (September 24, 2012).

P. Congo:

1. Rigzone, Murphy Oil Kicks Off Production at Azurite Offshore Congo, 10 August 2009, [http://www.rigzone.com/news/oil\\_gas/a/79097/Murphy\\_Oil\\_Kicks\\_Off\\_Production\\_at\\_Azurite\\_Offshore\\_Congo](http://www.rigzone.com/news/oil_gas/a/79097/Murphy_Oil_Kicks_Off_Production_at_Azurite_Offshore_Congo), (January 17, 2013).
2. SubSealQ – Offshore Field Development Projects, Azurite, 7 December 2012, [http://subseaiq.com/data/Project.aspx?project\\_id=370](http://subseaiq.com/data/Project.aspx?project_id=370), (January 22, 2013).
3. Chevron – Crude Oil Marketing, Djeno (Republic of Congo), 2011, <http://crudemarketing.chevron.com/crude/african/djeno.aspx>, (January 17, 2013).

Q. Ecuador:

1. Energy Information Administration – Country Analysis Briefs, Ecuador, September 2011.
2. Energy Information Administration – Country Analysis Briefs, Ecuador, <https://www.eia.gov/beta/international/analysis.cfm?iso=ECU>, October 5, 2017.
3. Capline, Most current approved assay list, <http://www.caplinepipeline.com/Reports1.aspx>, (January 23, 2013).

R. Equatorial Guinea:

1. Offshore Technology – Projects, Zafiro, <http://www.offshore-technology.com/projects/zafiro/>, (May 1, 2014).

S. Iraq:

1. Hydrocarbons Technology, Rumalia Oil Field Expansion, Iraq, <http://www.hydrocarbons-technology.com/projects/rumaila-oil-field-expansion/>, (September 24, 2012).
2. Wikipedia, Majnoon oil field, 18 April 2012, [http://en.wikipedia.org/wiki/Majnoon\\_oil\\_field](http://en.wikipedia.org/wiki/Majnoon_oil_field), (September 24, 2012).
3. BP Crude oil & refined products, Basra Light, <https://www.bp.com/en/global/trading/crude-oil-and-refined-products/crudes/middle-east/basra-light.html>, (February 14, 2018).
4. ExxonMobil – Worldwide operations-Crude Trading, Basrah Heavy, <http://corporate.exxonmobil.com/en/company/worldwide-operations/crude-oils/basrah-heavy>, (February 14, 2018).

T. Kuwait:

1. Energy Information Administration – Country Analysis Briefs, Kuwait, <https://www.eia.gov/beta/international/analysis.cfm?iso=KWT>, November 2, 2016.

U. Libya:

1. Libyan Petroleum Institute – Amna crude oil, November 2008.
2. Energy Information Administration – Country Analysis Briefs, Libya, <https://www.eia.gov/beta/international/analysis.cfm?iso=LBY>, November 19, 2015.

V. Malaysia:

1. ExxonMobil – Worldwide operations-Crude Trading, Tapis, <http://corporate.exxonmobil.com/en/company/worldwide-operations/crude-oils/tapis>, (February 14, 2018).

W. Mauritania:

1. Offshore Technology – Projects, Chinguetti Oil Field, Mauritania, <http://www.offshore-technology.com/projects/chinguetti/>, (May 1, 2014).
2. Rigzone, Hardiman Resources Ltd., Hardiman Announces First Cargo from Chinguetti, 5 April 2006, [http://www.rigzone.com/news/oil\\_gas/a/30991/Hardman\\_Announces\\_First\\_Cargo\\_from\\_C](http://www.rigzone.com/news/oil_gas/a/30991/Hardman_Announces_First_Cargo_from_C), (May 1, 2014).



#### X. Mexico:

1. Capline, Most current approved assay list, <http://www.caplinepipeline.com/Reports1.aspx>, (April 24, 2013).
2. Offshore Technology – Projects, Cantarell, <http://www.offshore-technology.com/projects/cantarell/>, (October 11, 2012).
3. Offshore Technology – Projects, Ku – Maloob – Zaap Field, <http://www.offshore-technology.com/projects/kumaloobzaap/>, (October 11, 2012).
4. Bailie, A., Trinko, D., Grier, J., and Karissa Coltman, Oil and Gas Journal, Guide to World Crudes, 15 May 2000, <http://www.ogj.com/articles/print/volume-98/issue-20/processing/guide-to-world-crudes.html>, (October 11, 2012).
5. SubSeaIQ – Offshore Field Development Projects, Cantarell, 9 November 2012, [http://www.subseaiq.com/data/Project.aspx?project\\_id=535](http://www.subseaiq.com/data/Project.aspx?project_id=535), (January 23, 2013).
6. SubSeaIQ – Offshore Field Development Projects, Ku-Maloob-Zaap, 7 June 2012, [http://www.subseaiq.com/data/Project.aspx?project\\_id=540&AspxAutoDetectCookieSupp&AspxAutoDetectCookieSupport=1](http://www.subseaiq.com/data/Project.aspx?project_id=540&AspxAutoDetectCookieSupp&AspxAutoDetectCookieSupport=1), (April 24, 2013).

#### Y. Neutral Zone:

1. Chevron – Crude Oil Marketing, Eocene, 2011, [http://crudemarketing.chevron.com/crude/middle\\_eastern/eocene.aspx](http://crudemarketing.chevron.com/crude/middle_eastern/eocene.aspx), (July 25, 2012).
2. Environment Canada – Emergencies Science and Technology Division, Khafji, [http://www.etc-cte.ec.gc.ca/databases/Oilproperties/pdf/WEB\\_Khafji.pdf](http://www.etc-cte.ec.gc.ca/databases/Oilproperties/pdf/WEB_Khafji.pdf), (January 18, 2013).
3. Chevron – Crude Oil Marketing, Ratawi, 2011, [http://crudemarketing.chevron.com/crude/middle\\_eastern/ratawi.aspx](http://crudemarketing.chevron.com/crude/middle_eastern/ratawi.aspx), (July 25, 2012).

#### Z. Nigeria:

1. Nigerian National Petroleum Corporation, 2010 Annual Statistical Bulletin (1<sup>st</sup> Edition), <http://www.nnpcgroup.com/PublicRelations/OilandGasStatistics/AnnualStatisticsBulletin/MonthlyPerformance.aspx>, (October 30, 2012).
2. Nigerian National Petroleum Corporation, 2015 Annual Statistical Bulletin (1<sup>st</sup> Edition), <http://www.nnpcgroup.com/PublicRelations/OilandGasStatistics/AnnualStatisticsBulletin/MonthlyPerformance.aspx>, (May 4, 2017).

AA. Oman:

1. Total Oil Trading SA, Crude Assays – Middle East, 2003, [http://www.totsa.com/pub/crude/index2.php?expand=5&iback=5&rub=11&image=middle\\_east](http://www.totsa.com/pub/crude/index2.php?expand=5&iback=5&rub=11&image=middle_east), (September 24, 2012).
2. Middle East Economic Survey (MEES), Oman to Lift Crude Output 80,000 B/D by End-2012, 17 November 2011, (September 24, 2012).
3. Mott MacDonald, Mukhaizna Heavy Crude Oil, (July 25, 2012).

BB. Peru:

1. Energy Information Administration – Country Analysis Briefs, Peru, May 2012, (June 13, 2012).
2. Perenco, <http://www.perenco-peru.com/>, (February 14, 2018).
3. David Casallas, Perenco-PetroVietnam begin Peru heavy crude production, December 5, 2013, <https://www.bnamericas.com/en/news/oilandgas/perenco-petrovietnam-begin-peru-heavy-crude-production>, (February 14, 2018).

CC. Russia:

1. Reuters, BP tests ESPO crude at US West Coast refinery, 31 March 2010, <http://www.reuters.com/article/2010/03/31/crude-espo-bp-usa-idUSSGE62U0F120100331>, (September 24, 2012).
2. Hydrocarbons Technology – Projects, ESPO Pipeline, Siberia, Russian Federation, <http://www.hydrocarbons-technology.com/projects/espopipeline/>, (July 25, 2012).
3. Exxon Neftegas Limited, Phases and Facilities, <http://www.sakhalin-1.com/en-ru/company/about-us/phases-and-facilities>, (February 14, 2018).
4. Rosneft, Sakhalin 1, 2013, [https://sakhalin1.rosneft.com/about/Rosneft\\_today/Operational\\_structure/Development\\_and\\_Production/Sakhalin1/](https://sakhalin1.rosneft.com/about/Rosneft_today/Operational_structure/Development_and_Production/Sakhalin1/), (February 14, 2018).
5. ExxonMobil – Worldwide operations-Crude Trading, Sokol, <http://corporate.exxonmobil.com/en/company/worldwide-operations/crude-oils/sokol>, (February 14, 2018).
6. Exxon Neftegas Limited, Oil transportation system, <http://www.sakhalin-1.com/en-ru/company/about-us/phases-and-facilities/chayvo>, (February 14, 2018).
7. Pennnet.com, Industry comparison, worldwide ERD experience, [http://images.pennnet.com/articles/os/cap/cap\\_142670.jpg](http://images.pennnet.com/articles/os/cap/cap_142670.jpg), (February 12, 2013).

8. Hydrocarbons Technology – Projects, Sakhalin II Crude Oil and Liquefied Natural Gas, Russian Federation, <http://www.hydrocarbons-technology.com/projects/sakhalin2/>, (October 12, 2012).
9. OnePetro – Document Preview, Society of Petroleum Engineers, Application of Smart, Fractured Water Technology in the Piltun-Astokhskoye Field, Sakhalin Island, Offshore Russia, 2006, <http://www.onepetro.org/mslib/app/Preview.do?paperNumber=SPE-102310-MS&societyCode=SPE>, (February 12, 2013).
10. Reuters, Vityaz crude lighter after Sakhalin II LNG startup, 19 May 2009, <http://in.reuters.com/article/2009/05/19/russia-crude-vityaz-idINSP46847820090519>, (February 12, 2013).
11. The Oil Drum, Tech Talk – Oil Production from the Volga-Ural Basin, 15 January 2012, <http://www.theoil Drum.com/node/8833>, (December 5, 2012).
12. Wikipedia, Romashkino Field, [https://en.wikipedia.org/wiki/Romashkino\\_Field](https://en.wikipedia.org/wiki/Romashkino_Field), (February 14, 2018).

DD. Saudi Arabia:

1. Bates B., Oscar for an Oilfield, Saudi Aramco World, volume 24, number 6, November/December 1973, <http://www.saudiaramcoworld.com/issue/197306/oscar.for.an.oilfield.htm>, (September 24, 2012).
2. Capline, Most current approved assay list, <http://www.caplinepipeline.com/Reports1.aspx>, (February 12, 2013).
3. Offshore Technology – Projects, Safaniya Field Upgrade, Persian Gulf, Saudi Arabia, <http://www.offshore-technology.com/projects/safaniya-upgrade-persian-gulf/>, (May 1, 2014).

EE. Thailand:

1. Offshore Technology – Projects, Salamander Energy Bualuang Oil Project, Gulf of Thailand, Thailand, <http://www.offshore-technology.com/projects/salamandabualang/>, (October 12, 2012).
2. Salamander Energy, Greater Bualuang, <http://salamander-energy-annual-report-2011.production.investis.com/business-review/greater-bualuang.aspx>, (October 12, 2012).

FF. Trinidad:

1. The Trinidad Guardian – Online Edition, BHP's Angostura average 42,000 bpd in first year, 19 January 2006, <http://legacy.guardian.co.tt/archives/2006-01-21/bussguardian7.html>, (July 25, 2012).

2. TOTSA Total Oil Trading SA, Crude Assays – Latin America, 2003, [http://www.totsa.com/pub/crude/index2.php?expand=4&iback=4&rub=11&image=latin\\_america](http://www.totsa.com/pub/crude/index2.php?expand=4&iback=4&rub=11&image=latin_america), (September 24, 2012).
3. BP Crude oil & refined products, Galeota Mix, <https://www.bp.com/en/global/trading/crude-oil-and-refined-products/crudes/americas/galeota-mix.html>, (February 14, 2018).

GG. UAE (Abu Dhabi):

1. A Barrel Full, Murban Crude Oil, <http://abarrelfull.wikidot.com/murban-crude-oil>, (February 14, 2018).
2. Energy Information Administration – Country Analysis Brief, United Arab Emirates, March 21, 2017, <https://www.eia.gov/beta/international/analysis.cfm?iso=ARE>, (February 14, 2018).
3. ExxonMobil Worldwide operations Crude Trading, Upper Zakum, <http://corporate.exxonmobil.com/en/company/worldwide-operations/crude-oils/upper-zakum>, (February 14, 2018).

HH. Venezuela:

1. USGS – World Petroleum Resources Project, An Estimate of Recoverable Heavy Oil Resources of the Orinoco Oil Belt, Venezuela, October 2009, <http://pubs.usgs.gov/fs/2009/3028/pdf/FS09-3028.pdf>, (June 15, 2012).
2. Hydrocarbons Technology – Projects, Petrozuata Pipeline and Upgrader Plant, Venezuela, <http://www.hydrocarbons-technology.com/projects/petrozuata>, (July 25, 2012).
3. Total, Total in Venezuela – Venezuela Field Trip, September 2003, (July 5, 2012).
4. Chourio, G., Bracho, J., and M. Mohtadi, Evaluation and Application of Extended Cyclic Steam Injection as a New Concept for Bachaquero-01 Reservoir in West Venezuela, Society of Petroleum Engineers, SPE 148083, 2011.
5. Hydrocarbons Technology – Projects, Hamaca Ameriven Syncrude Project, Venezuela, <http://www.hydrocarbons-technology.com/projects/hamaca/>, (October 17, 2012).
6. A Barrel Full, Jusepin Oil Field, February 5 2014, <http://abarrelfull.wikidot.com/jusepin-oil-field>, (February 14, 2018).
7. Oil and Gas Journal – International Petroleum news and Technology, Sincor to offer Zuata Sweet crude in 2002, volume 99, issue 29, 16 July 2001, <http://www.ogj.com/articles/print/volume-99/issue-29/processing/sincor-to-offer-zuata-sweet-crude-in-2002.html>, (July 25, 2012).

### **XIII. APPENDICES**

Appendix A:	Proposed Regulation Order
Appendix B:	Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard
Appendix C:	CA-GREET3.0 Technical Support Documentation
Appendix D:	Environmental Analysis
Appendix E:	Summary of DOF Comments to the LCFS 2018 Amendments SRIA and CARB Responses
Appendix F:	Methodologies Estimating Potential GHG and Criteria Pollutant Emissions Due to the Proposed LCFS Amendments
Appendix G:	Supplemental Disclosure of Oxides of Nitrogen Potentially Caused by the Low Carbon Fuel Standard
Appendix H:	Analyses Supporting the Addition or Revision of Energy Economy Ratio Values for the Proposed LCFS Amendments
Appendix I:	Estimating Carbon Intensity Values for the Crude Lookup Table