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POLICY INSTITUTE FOR ENERGY, ENVIRONMENT, AND THE ECONOMY

9 May, 2024

State of California, Air Resources Board
Industrial Strategies Division, Transportation Fuels Branch
California Air Resources Board
1001 I St.
Sacramento CA, 95814

Re: Comments on April 10, 2024 Workshop

Dear LCFS Staff:

Thank you for the opportunity to comment on the current rulemaking to amend the Low Carbon Fuel Standard (LCFS). The University of California, Davis Institute of Transportation Studies, and the Policy Institute for Energy, Environment, and the Economy have been engaged in research, policy analysis, and technical assistance relating to the LCFS since it was first developed, over 15 years ago. Since then, it has become a critical part of California's climate policy portfolio and a model that has been adopted in many other jurisdictions around the world. Following the strategic vision laid out in the 2022 Scoping Plan, the LCFS would continue to support profound changes in California's transportation and energy systems in order to meet the statutory goals of a 40% reduction in greenhouse gas (GHG) below 1990 levels by 2030, and carbon neutrality by 2045.[1]

California's progress toward its climate policy goals stands at a critical inflection point in 2024. Our policies have helped bring many critical low-carbon technologies onto the market at massive scale, and often lower cost than initially projected. Wind and solar power, lithium-ion batteries, and electric vehicles (EVs) have emerged as invaluable tools in the struggle to limit climate change, in large part because of California's forward-looking policies. While it is perfectly appropriate to recognize these successes, we must not assume that simply staying the course will achieve our long-term goals. As technologies, markets, and consumer behavior evolve, so must policies evolve with them. The process of converting a fossil-fuel dominated energy system to a low-carbon renewable one will not follow a simple, consistent path. There will be twists and turns along the way, and as policies begin to transform our energy and transportation system, we must critically re-evaluate existing policies, analyses, and the assumptions that underpin them to be certain that our state is course towards an efficient and equitable transition.

This is certainly true in the case of the LCFS. The LCFS has successfully guided the evolution of California's transportation fuels for almost 15 years, supporting the deployment of low-carbon

[1] SB 32 (Pavley, Chapter 249, Statutes of 2016), AB 1279 (Muratsuchi, Chapter 337, Statutes of 2022)

biofuels, electric vehicles, and other advanced technologies. To date, the LCFS has displaced over 25 billion gallons of petroleum fuels with lower-carbon alternatives, and achieved a 12.6% reduction in carbon intensity of our fuel portfolio. These successes deserve recognition and should not be taken for granted. At the same time, we should not take for granted that critical policies like the LCFS will maintain their effectiveness without continuous, science-based updates. The 2024 LCFS rulemaking is among the first opportunities for reflection and review of existing tools, so that California can continue to be a model of effective climate policies..

We commend Staff for facilitating a robust series of workshops over the last two years, and for their willingness to engage with stakeholders on this complex issue. These comments are presented in the spirit of UC Davis' and the Policy Institute's mission to bring science into the policy process. Neither UC Davis nor the Policy Institute seek a specific policy outcome; these comments are offered to help California meet its climate, environmental, and equity goals. We focus the majority of these comments on two main topic areas: Market modeling and compliance trajectories, as well as Feedstock Sustainability and Indirect Land Use Change.

Market Modeling and Compliance Trajectories

At the April 10th workshop, Staff presented updated CATS modeling showing the results of several new scenario analyses, and updates to input data. Our own FPSM modeling confirms many of the key points from the workshop: EVs will generate the majority of LCFS credits by 2030, and most crop-based biofuels will cease to be credit-generating fuels by the early- to mid-2030's.[2]

Recent LCFS program data have indicated that the pace of credit bank accumulation continues to increase, with almost 3 million additional credits added to the aggregate bank in Q4 of 2023. This is the largest quarterly aggregate bank increase in the program's history, over 700,000 more than the previous record, set in Q3 of 2023. The total bank now exceeds the total number of deficits generated in 2023, and is clearly indicative of a significant oversupply of compliance credit relative to regulatory obligations. Our own modeling projects that this growth trend will continue, due to the rapid expansion of renewable diesel (RD) production capacity in the U.S. which could supply virtually all additional compliance credit required under higher targets for the next several years at least.[3] We have discussed, in our published reports as well as previous

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[2] It should be noted however, that even once these fuels cease to generate credits, they will generate significantly fewer deficits than petroleum. The sum of credits plus avoided deficits between petroleum and biofuels will remain the same, even when biofuels generate no credits.

[3] **Initial report**: Ro, J., Murphy, C. W, & Wang, Q. (2023). Fuel Portfolio Scenario Modeling (FPSM) of 2030 and 2035 Low CarbonFuel Standard Targets in California. *UC Office of the President: University of California Institute of Transportation Studies*. http://dx.doi.org/10.7922/G2S46Q8C Retrieved from https://escholarship.org/uc/item/6f2284rg

LCFS comments, why higher targets alone are unlikely to resolve the underlying structural imbalance in the market caused by the unprecedented expansion of RD production capacity, and showed why a restriction on the ability of RD to enter the market, such as a cap on volumes of fuels from specified types of feedstock, appears to be the most viable path among alternatives aired thus far by CARB to push the market quickly toward credit balance.

Reviewing the CATS Modeling Framework and Results

Many of the CATS model outputs align with those from FPSM, however the models vary greatly in how they project future consumption of RD; understanding the mechanisms behind these differences can help explain why CATS is structurally predisposed to forecasts of lower RD growth than FPSM.

CATS is an optimization model that develops feedstock supply curves for various fuels by a mix of regression analysis and use of other literature. For lipids, earlier technical documentation from CARB indicated supply curves are derived from historical trends in feedstock quantities and wholesale biodiesel prices, using regression analysis to estimate a relationship used to indicate price responsiveness – i.e., feedstock supply curves – in the model. This regression uses a simplified model, with fuel price (along with constant and error terms) associated with lipid supply levels . According to the recent staff presentation, the updated model accounts for time trends in feedstock supply and aligns timeframes in analysis for the different types of oils (residual oils and vegetable oils). While this approach provides an association between quantities supplied and price, its use requires care in interpretation of the outputs.[4] Because demand constitutes another key quantity/price relationship, use of just price and quantity might not definitively identify the supply relationship, absent other statistical methods to control for this key endogeneity. Nor does the estimation control for other factors that may influence biomass-based diesel (renewable diesel as well as biodiesel) price and resulting lipid supply as fuel feedstock, such as those noted on slide 54 from the April 10th workshop. Given what we know about how agricultural commodities markets function, however, it is unlikely that biofuel price is the only variable with significant explanatory power over the supply of biofuel feedstock in U.S. commodities markets.[5] Effectively mapping the supply curve with higher fidelity to

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2024 update: Murphy, C., & Ro, J. (2024). Updated Fuel Portfolio Scenario Modeling to Inform 2024 Low Carbon Fuel Standard Rulemaking. *UC Davis: Policy Institute for Energy, Environment, and the Economy*. http://dx.doi.org/10.7922/G25719BV https://escholarship.org/uc/item/5wf035p8

[4] The limitations on fuel market data are observed and discussed in Mazzone, *et al.* (2022) https://escholarship.org/uc/item/7vx4c5wr

[5] It is entirely possible that no data were available to allow exploration of other model specifications, or that full analysis of other functional forms would have increased the complexity of the econometric modeling beyond what was tractable for CARB staff at the time. We merely observe that only a single explanatory variable appears to have been examined and only a single functional form of the modeled relationship is discussed in the CATS documentation. These factors should be considered when interpreting the results from the model.

real-world behavior would require either a structural approach with a more complicated set of equations and explanatory variables, or some exogenous source of variation in the demand for lipids. As CATS had neither, the supply curves it uses are best viewed as highly approximate and heavily abstracted correlations, which may not accurately represent future market behavior.

Perhaps even more fundamentally, given large, and largely unprecedented, shifts in the lipids markets for biofuels under policy accompanying the renewable diesel boom, historical supply relationships may provide less of an indicator of future responsiveness to price than they would in a more stable situation. While all data describing a relationship are, by necessity historical, the difficulties in identifying supply curves and the fast-changing nature of the lipid markets for biofuels indicate caution in interpretation. These projections of feedstock supply to fuel price are highly uncertain and may not reflect future behavior. Additionally, the conversion costs represented in the historical dataset reflect the earliest entrants onto the market; these are likely to have higher conversion costs and lower yields due to technological immaturity and the higher capital costs and risk premiums associated with newly-emerged technologies. As a result, CATS analysis may overstate the costs, and underestimate future RD growth. The CATS output for the proposed 5% step-down scenario forecasts a nearly 16% reduction in RD consumption between 2023 and 2024, an outcome that appears highly unlikely given preliminary data on fuel consumption trends in early 2024. Even the more aggressive step-down scenarios project RD consumption to reach a high point in 2024 and decline gradually thereafter, despite continued use of petroleum diesel and generally strong projected LCFS credit prices.

This counterintuitive behavior is, in part, an artifact of how CATS performs its least-cost optimization to set the portfolio of fuels for compliance in a given year. CATS assembles the least-cost portfolio that provides enough credit to match the total amount of deficit generation in a given year; credit banking does not occur except in extraordinary circumstances, such as when prices are zero or at the statutory ceiling. The model therefore assumes that obligated parties and fuel producers will produce precisely enough credit for yearly compliance, but no more. In practice, however, credit banking is a significant phenomenon in the LCFS and an important part of how the market hedges against future market volatility and finds the lowest cost compliance options. The last two years of LCFS performance clearly establish the fact that market participants will over-produce credit-generating fuels, relative to total annual deficit obligations, and bank surplus credits for future years. CATS design cannot represent the behavior that has dominated the LCFS market over the last 2-3 years, and is therefore likely to underestimate future RD consumption in California. Given that this behavior is probably an artifact of CATS' structure, caution must be exercised when using CATS outputs to guide policy decisions.

We want to be clear that these critiques of CATS reflect the difficulties in modeling this space with current data, and under time pressure. LCFS modeling is complex, critical data are scarce and unreliable, and the system is beset by numerous compounding factors. CATS adopts understandable modeling principles given constraints and makes its assumptions transparent through the public documentation. Our critiques are meant to highlight that care must be taken when using quantitative outputs from CATS as policy guidance, and as with any model, the limitations of the modeling methodology must be considered alongside any outputs.

Higher Step-Downs Will Not Address the Core Market Imbalance

At the April 10th workshop, Staff presented scenarios that analyzed target increases taking effect Jan 1, 2025 that were 5%, 7%, and 9% higher than 2024 (this large one-time target increase is often referred to as a “step-down”). The aggregate credit generation through 2046 is presented for these scenarios on slide 47. FPSM modeling generally aligns with the bank drawdown results; we predict a net drawdown of around 8 million credits through 2035 for the 7% step-down as compared to the 5% one, and an additional 7 million credits for the 9% step-down as compared to the 7%. These results are quite similar, when accounting for the different temporal scope of each model.

While these larger step-downs do reduce the size of the net bank of credits in 2030 and beyond, that reduction is unlikely to significantly impact the long-term balance of credits and deficits in the LCFS, and is therefore unlikely to significantly affect credit price. While CATS does not explicitly model the size of the credit bank, FPSM does, and the scenarios we published in February project a bank of over 60 million credits in 2030, compared to 35 million deficits under a 30% target. If the automatic acceleration mechanism (AAM) as described in the current amendments is triggered - and FPSM modeling indicates that is the most likely outcome if these amendments are adopted as-is, the bank will remain nearly the same size, but 45 million deficits will be generated in 2030. Under these conditions, reducing the bank by 15 million credits - approximately the difference between the 5% and 9% step-down rates - still leaves the credit bank significantly above the threshold for triggering additional AAM events in the future. Given the current market dynamics, a higher step-down is therefore unlikely to significantly shift the balance of credits and deficits through 2030. While we would anticipate the higher deficit generation from a larger step-down to increase aggregate demand for LCFS credits, renewable diesel will continue to set the marginal cost of compliance under the LCFS, which suggests that a larger step-down is likely to have little impact on credit prices over the next few years.

Renewable Diesel is Setting the LCFS Credit Price, and Will Continue to Do So Under the Proposed Amendments

Our research group has released two reports in the last year related to modeling of California’s LCFS through 2035. The more recent of these reports details evidence of a recent, and very significant shift in alternative fuel market dynamics in California. The LCFS has historically supported a variety of fuels and technologies, including ethanol, biodiesel, renewable diesel, renewable natural gas, electricity, hydrogen and others. Despite some of these technologies being more mature and lower-cost than others, no single technology or fuel pathway was able to dominate the market or grow in such a fashion that it restricted or crowded out the others. This is, in large part, because the growth of each technology or fuel type was constrained by limits imposed by factors outside of the LCFS. Ethanol, for example, was constrained by the E10 blend wall and the limited uptake of higher-ethanol blends like E85. Electricity, renewable natural gas, and hydrogen were constrained by the relatively limited number of vehicles capable of consuming these fuels. Biodiesel was subject to blend limits and infrastructure compatibility challenges, which limited its potential growth.

Renewable diesel (RD), however, was not subject to similar inherent limitations on its growth. Since it can be used at 100% blends in virtually all diesel engines, and is broadly compatible with existing distribution infrastructure (and additional infrastructure, e.g., pipelines, has emerged alongside the increased consumption in the state), the only limit on the amount that could be consumed in California is the total production available to our market, or the total consumption of diesel fuel and diesel substitutes. Prior to 2020, total global capacity to produce RD was quite limited, and much of what existed was sold into the European market; this capacity limit prevented runaway growth for RD in the California market, despite robust incentives. Rapid deployment of RD production capacity in North America over the last 3-4 years, however, has effectively eliminated this constraint.[6] As a result, volumes of RD entering the California market have grown very rapidly, more than tripling since 2020, to almost 2 billion gallons in 2023.[7] Approximately 61% of total diesel consumed in California in 2023 was biodiesel or renewable diesel.

While the displacement of petroleum fuels by lower carbon alternatives is one of the primary goals of the LCFS, this development also carries with it several significant risks that have been inadequately addressed by the analysis presented in LCFS workshops and hearings. One of these, related to indirect land use change (ILUC) risk will be discussed later in this comment. Another significant risk is that continued growth of RD will continue to hold LCFS credit prices down, and crowd out other fuels for the next several years. LCFS credit prices fell below $100 in mid-2022, and have generally been between $60 and $75 for the last 18 months. This is widely considered to be too low to support the deployment of many critical low-carbon fuel infrastructure and production capacity projects, notably medium- and heavy-duty EV charging infrastructure, cellulosic fuel or e-fuel production capacity, and carbon capture and sequestration

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[6] EIA, Domestic renewable diesel capacity could more than double through 2025 - U.S. Energy Information Administration (EIA). *https://www.eia.gov/todayinenergy/detail.php?id=55399* and M. Gerveni, T. Hubbs, and S. Irwin, “Revisiting Biomass-Based Diesel Feedstock Trends over 2011-2022” (2024); *https://farmdocdaily.illinois.edu/2024/01/revisiting-biomass-based-diesel-feedstock-trends-over-2011-2022.html*

[7] CARB Quarterly Data Summary Spreadsheet. https://ww2.arb.ca.gov/sites/default/files/2024-04/quarterlysummary_Q42023.xlsx

(CCS) projects. Renewable diesel, however, has continued its very rapid growth during this period, indicating that LCFS credit prices in this range are sufficient to support its growth.

Staff's presentation on April 10th acknowledged that U.S. RD production capacity was sufficient to displace all of California's diesel consumption, and the last three years have provided ample evidence that large volumes of RD are available to the California market at LCFS credit prices in the $60-80 range. Despite gradual reductions in RIN prices, the pace of RD production capacity growth shows little sign of abating, with over 1 billion gallons of nameplate capacity expected to come online in California during 2024, with more slated in other parts of the U.S.. This continued capacity growth indicates that significant volumes of RD in addition to what is already consumed in California will be available this year or shortly thereafter. Even with higher deficit generation due to increased program targets, including large step-downs, the amount of RD available is sufficient to supply all additional compliance credit needs for the next 2-3 years at least.

Market mechanisms like the LCFS are explicitly designed to minimize total compliance costs by giving obligated parties the flexibility to pick the most attractive route to compliance. RD has clearly demonstrated itself to be the lowest-cost option to expand credit generation over the last 2-3 years. This can continue for several more years at least, until the remaining 40% of our total diesel demand that continues to be satisfied by petroleum, around 1.5 billion gallons/year, is converted to RD.

Rapid growth of RD is not always a negative outcome. Displacing fossil fuels with alternatives is, in fact, a primary goal of the LCFS and we are reasonably confident that the RD that has entered the state to date is lower-carbon than petroleum over its full life cycle. So it is reasonable to ask why California should rein in this rapid transition to RD. There are two primary reasons for this. First, the analysis of the carbon intensity of RD used by the LCFS includes estimates of indirect land use change impacts that are outdated and do not reflect current market conditions. It is likely that actual life cycle GHG emissions from many RD pathways are higher than their certified CI scores under the program, and as volumes increase the per-gallon ILUC impacts are likely to increase as well. There is a significant risk that GHG benefits from continued RD growth will be significantly smaller than their LCFS credit generation would imply, or even that future RD may no longer provide significant GHG benefits when displacing petroleum. We will discuss ILUC in more depth later in this comment. Second, even where RD GHG benefits are appropriately quantified, the technology has limited potential to reduce emissions significantly below current levels. Waste-based RD pathways can achieve 70-80% reductions in life cycle GHG emissions compared to petroleum diesel, however the supply of wastes is extremely limited. Byproduct or coproduct feedstocks, or crop-based ones, cannot achieve deep GHG reductions due to emissions from feedstock production. While some opportunities to reduce GHG emissions from RD production exist, such as the use of low-carbon hydrogen or sequestration of process emissions, these cannot fully offset all production emissions. This means that RD lacks a plausible pathway to zero or near-zero emissions for non-waste feedstocks and is best viewed as a bridge fuel, to help reduce emissions while zero-emission options like EVs are deployed. Under current market conditions, RD is likely to dominate the market for additional compliance credit until California's diesel pool is fully saturated, depriving other technologies that may have a better capacity to provide zero-emission transportation fuel in the future of badly-needed investment. While continued LCFS target increases will eventually result in some varieties of RD no longer generating credits, this is not expected to occur for 5-10 years. During the years when uncontrolled growth of RD allows it to continue setting the marginal cost of LCFS compliance, technologies that need a higher credit price to deploy will be unable to receive the amount of incentive they need. This will result in several years in which we would expect minimal investment in technologies apart from RD, which will mean several years of lost opportunities for zero- or near-zero carbon technologies to enter the market and begin maturing. While the reliance on RD may minimize short-term LCFS compliance costs, it would likely increase the long-run cost of achieving carbon neutrality.

This is not to say that complete removal of RD from the LCFS is advisable. Bridge fuels can play a valuable role in the transition to zero-carbon transportation and even the most optimistic projections of EV deployment predict billions of gallons of liquid fuel demand in the on-road space through the mid-2040's or longer; most liquid fuels have the potential to shift into the aviation market which will likely be dependent on liquid fuels for several more decades.[8] To the extent bridge fuels can be made from wastes, residues or feedstocks that pose little risk or ILUC or other indirect effects, these fuels can provide critical near-term emissions benefits and help displace petroleum. To the extent that our comments sound a cautionary note about RD and other lipid-based fuels, we emphasize that the concern is more focused on continued growth of these fuels at present rates. Our February report and comment letter evaluates several options for restricting the growth of these fuels. We conclude that while a cap is a relatively blunt, imperfect approach, it is probably the only one that can feasibly be implemented within the timeframe of the current rulemaking, and offer the following suggestions regarding effective cap design and implementation.

- The cap could target either crop-based feedstocks, all lipids or both. Targeting crop-based feedstocks allows for greater use of wastes and residues, but a cap on all lipids offers better protection against ILUC risk.
- Setting the cap at approximately 2022 levels of consumption - 500 million gallons/year of crop-based fuels or 2 billion gallons/year of lipid based fuel - offers a good degree of certainty that the market will be brought back into balance and the AAM will not be triggered, thereby minimizing gas price impacts to California consumers. 1 billion

[8] Brown, *et al.* (2021) *Driving California's Transportation Emissions to Zero by 2045* https://escholarship.org/uc/item/3np3p2t0

gallons/year of crop-based fuels, or 3 billion gallons/year of lipid-based fuels are both likely to trigger 2 AAM events and result in a 39% LCFS target in 2030.

- The cap could be implemented by duplicating the existing LCFS Reporting Tool and Credit Bank & Transfer System (LRT-CBTS) to create a separate credit tracking platform for the specified credit types (those based on crop or lipid feedstocks). Alternatively, CARB or a designated entity could establish a quota system for producing fuels from the specified feedstock types, in which case credits would only be issued for those fuels when the producer can show they have obtained an adequate share of the quota.
- The cap could be imposed as a temporary measure, until a permanent solution could be developed.
- If a cap is set at levels below present-day consumption of the specified fuel types, then a phase-in period should be granted to allow time for producers to find alternative markets for their product.

Reasons Stated for Rejecting the EJ Alternative or Alternative 1 Do Not Negate the Need to Restrict Crop-Based Biofuel Growth

At the April 10th workshop, Staff reiterated the reasons for rejecting alternatives proposed in the ISOR that included a cap on crop-based fuels, the EJ Scenario and Alternative 1. These included lower total GHG reductions and air quality improvement. We appreciate the additional explanation provided by Staff at the workshop, however the reasons specified do not rebut the need to restrict the growth of BBD.

First, both scenarios adopt unnecessarily tight restrictions on the total quantity of lipid-based fuels (biodiesel, renewable diesel, and SAF, all of which are made from fats, oils and greases). Alternative 1 peaks at around 2 billion total gallons of these fuels, but consumes significantly less in most years. The EJ Scenario limits the total to around 1.4 billion gallons. Our recent paper and previous comment identify 2 billion gasoline-equivalent gallons as a level of consumption under which we have a high confidence that no AAM triggering events will be initiated; setting the cap slightly above this level may also allow the supply of credits and deficits in the market to be brought back into balance. CATS model outputs for the proposed 7% step-down scenario modeling outputs show that lipid based fuel consumption never exceeds 2.4 billion gallons. As discussed above, the structure of CATS and lack of banking behavior suggest that this is a significant underestimate of actual lipid-based fuel consumption under such a scenario, however it does confirm that the market can meet even more ambitious step-down levels with a cap on crop- or lipid-based feedstocks. Moreover, the total quantity of GHG reductions from biofuels under a the 2 billion gallon total lipids cap scenario we analyzed in our recent report will be quite similar to those presented in the 7% step-down scenario. Because the total volumes of BBD and SAF are approximately equivalent, we would expect similar air quality impacts as well.

Staff also noted that the restrictions on BBD and SAF use would reduce air quality benefits as compared to a scenario in which the use of these fuels was unrestricted. While both BBD and SAF offer some air quality benefits, when displacing petroleum fuels, the additional benefits are minimal when considered in the context of total state emissions. The difference in state-wide PM2.5 emissions between the EJAC scenario and the proposed alternative was 1.43 tons per day at its maximum, in 2025, and less than 1 ton per day for all years after 2028. This compared to total statewide PM2.5 emissions of over 960 tons per day through this period, of which, around 370 tons per day are from anthropogenic sources, and around 50 are from mobile sources. This means that the reduction in PM is around 0.4% of total anthropogenic emissions, or less than 0.2% of total emissions. Given the inherent uncertainties in projecting future vehicle fleet composition and behavior, the potential PM benefit from higher levels of BBD and SAF are quite probably smaller than the inherent uncertainty associated with these modeling tools.

The analysis of the NOx impacts show even less benefit for the Proposed Scenario as compared to the EJ Scenario. First, it should be noted that the CARB analysis finds a NOx benefit from the use of SAF, whereas guidance from the National Academies of Science indicates no significant NOx benefits from blend levels <50%.[9] The impact of SAF on total NOx emissions from aircraft is small in this analysis, however, and new data are constantly emerging on the impacts of SAF on modern jet turbine engines. Even assuming significant NOx impacts from SAF, the EJ scenario shows lower state-wide NOx emissions than the Proposed Scenario through 2036. Similar to the PM2.5 analysis, the difference between these two scenarios is significantly less than 1% of total anthropogenic emissions in all years, and likely smaller than the uncertainty associated with the modeling tools and data sources employed.

Taken together, the PM and NOx emissions benefits from the Proposed Scenario, which does not limit the use of biofuels, are minimal and significantly smaller than the uncertainty inherent in the modeling tools used to perform this analysis. PM and NOx benefits do not provide a compelling reason to reject caps on crop- or lipid- based biofuels.

Finally it should be noted that the higher GHG benefits Staff's analysis ascribes to unrestricted consumption of biofuels depends on the pathway CI scores for such fuels actually matching real-world performance. Given the uncertainty around ILUC adjustment factors, which will be discussed in the next section, this cannot be taken for granted. The purpose of a cap on crop- or lipid-based biofuels is, in part, to limit the potential damage if real-world GHG emissions exceed certified pathway CI scores. Given the likelihood that ILUC impacts from lipid based fuels are significantly higher than the values currently used in the LCFS, it is possible that the purported GHG benefits of scenarios with no cap or limitation on consumption are less than expected.

[9] ACRP (2019),. *Alternative Jet Fuels Emissions Quantification Methods Creation and Validation Report,* https://onlinepubs.trb.org/onlinepubs/acrp/acrp_wod_41.pdf

Feedstock Sustainability and Indirect Land Use Change

A second major area of discussion at the April 10th workshop concerned feedstock sustainability requirements and indirect land use change (ILUC) risk mitigation. Staff provided more detail regarding the feedstock sustainability certification proposed in the 45-day amendment package, as well as provisions for ILUC assessment in cases where the feedstocks used are outside the scope of ILUC adjustment values reported in Table 6 of the regulation.

While we appreciate the additional discussion, and staff's efforts to strengthen the proposed sustainability certification provisions, as well as address stakeholder feedback about novel ILUC scenarios, the new proposals do not effectively address the concerns we discussed in our February 20th comment letter. Even with the concepts discussed at the April 10th workshop, the proposed amendments fail to address the serious risk that the LCFS will drive harmful land use change due to increased biofuel consumption. In that case, not only would GHG emissions be significantly higher than the pathways CI scores would indicate, but California's fuel policy would be supporting patently unsustainable land conversion, loss of ecosystems, and encroachment on culturally sensitive lands. Significant additional steps are required to effectively mitigate this risk. New modeling is required to update the ILUC adjustment values in table 6 to bring them into line with current data and scientific understanding of land use change, and they must be regularly reviewed and updated in the future.

Proposed Sustainability Guardrails Are Inadequate Protection Against Environmental Risks

At the April 10th workshop, staff proposed a set of sustainability "guardrails" to protect against land use change risk, food vs. fuel competition, and other negative environmental impacts from the use of biofuels. Staff requested information and perspectives from stakeholders on several key questions related to vegetable oil consumption for biofuels, provided additional information regarding previously proposed feedstock sustainability requirements, and proposed additional provisions relating to indirect land use change (ILUC) impacts from feedstocks sourced outside the U.S. We appreciate the additional clarity provided by staff about these provisions, and agree that feedstock sustainability requirements are a useful tool that should be part of the LCFS. Even with the clarification and new proposals however, the proposed amendments create a severe risk of spurring ILUC-driven deforestation, which in turn causes significant GHG emissions, loss of biodiversity and critical ecosystems, and negative impacts on local communities.

The material presented at the April 10th workshop does not articulate a response to the analysis we presented in our 2024 report or Feb 20th comment letter; these issues were corroborated by comments submitted by several other independent, non-profit organizations and land use researchers.[10] The proposed feedstock sustainability requirements can only be applied to the quantities of vegetable oil being used to produce fuels that are credited under the LCFS. While appropriately designed and implemented sustainability guidelines can help ensure that this feedstock is grown and processed according to best practices, all extant sustainability certifications we are aware of are blind to the impacts of ILUC, which occur elsewhere in the world. When soybean oil that was historically exported into global vegetable oil markets is instead turned into biofuels in the U.S., alternative sources of vegetable oil emerge to replace that lost supply. Some of that replacement is obtained by bringing more land into cultivation, this is the mechanism by which ILUC occurs. The majority of total global vegetable oil consumption occurs in markets that lack effective sustainability certification systems. So long as markets present sufficient demand to accommodate the amount of oil grown on recently-deforested land, sustainability certifications will be unable to prevent ILUC.

Sustainability Certification Systems Could Mitigate ILUC Risk If They Can Show That Feedstock Used For Biofuels Does Not Result in Unmet Demand Elsewhere

Staff asked for input on how sustainability certifications could be applied to reduce ILUC risk. Given their limited scope, as discussed above, we can think of only one way that they could effectively limit ILUC risk: by ensuring that there was no prior use of feedstock that came from the source in question. ILUC is ultimately caused by increasing net demand for agricultural commodities, when fats, oils, and greases are taken from a previous use and redirected to biofuels, the previous consumer now has an unmet demand. That demand came into existence because of the expansion of biofuel production, even though the entity that actually directly responsible for the demand may be completely unconnected to the biofuel industry and in a different country. If certification systems could provide strong certainty that the use of a specified lot of feedstock did not result in the creation of unmet demand, it would provide significant reassurance that ILUC impacts were low.

Certifying that a specific lot of feedstock, when used to produce biofuels, would not cause unmet demand is difficult, however, and may require extensive documentation that is not routinely collected at present. Certification bodies would have to provide certainty that the feedstock would not otherwise have gone to some productive use that would demand an alternative if they lost access to their *status quo* feedstocks. For example, if it could be conclusively documented that waste or residue oils had historically been disposed of in a landfill, or by incineration, and the feedstock provider could provide credible documentation of

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[10] Murphy & Ro, *UC Davis Comment on Proposed LCFS Amendments.* https://www.arb.ca.gov/lists/com-attach/7085-lcfs2024-Wi9QNQNdAzRXMAF3.zip

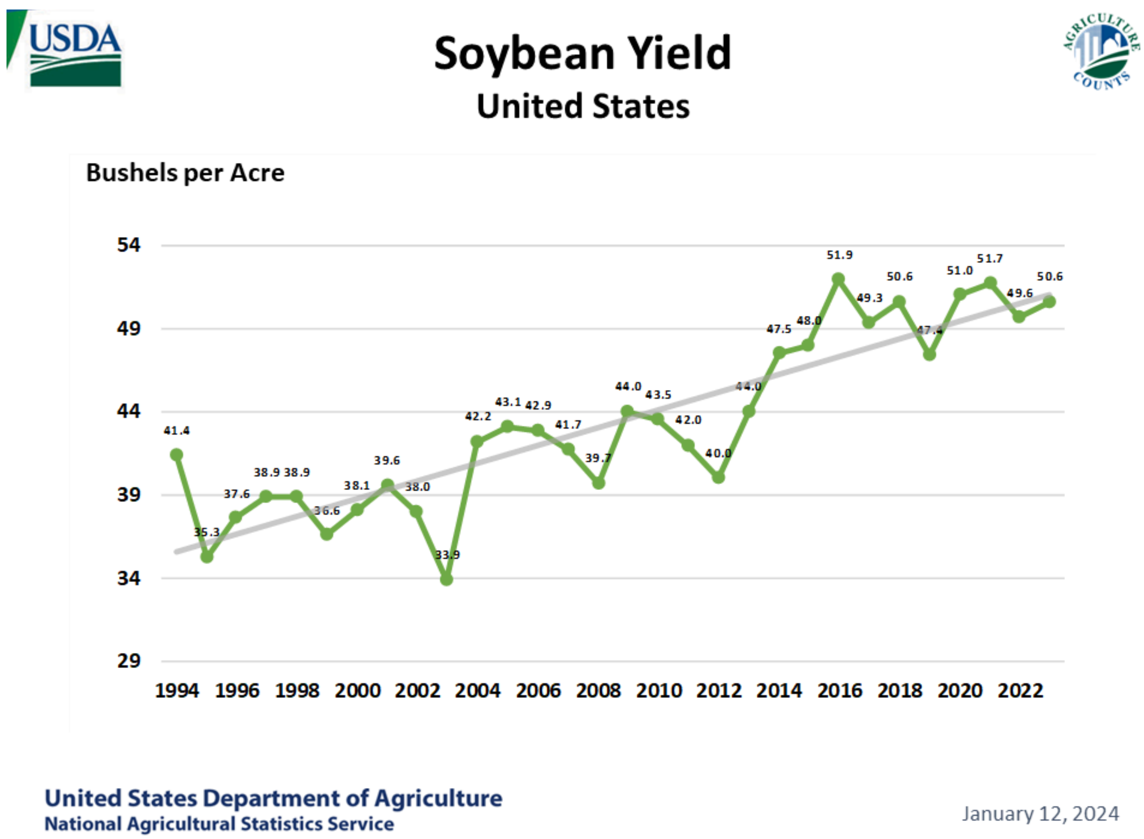
this historical behavior, then that feedstock could be reasonably said to have no ILUC impact.[11] For crop-based feedstocks, the producer would have to be able to demonstrate that the land used to produce the feedstock had not been in productive use, or that there would be no unmet demand arising from the redirection of feedstock away from a previous use and into biofuels instead. We note that most certification systems protect against emissions from direct land use change by refusing to certify feedstocks grown on land that has not been under cultivation for an extended period of time. This means that the certification conditions required to prevent direct land use change - that the land has been under cultivation - and the conditions required to prevent indirect land use change - that no useful products had historically been produced on the land used to grow feedstock - would combine to exclude the vast majority of land from being able to produce feedstock that could be certified as sustainable. This is why certification systems are generally not well-suited for mitigating against ILUC risk, and model-based approaches are typically preferred.

Current Evidence Suggests that Biomass Based Diesel Demand is Affecting Global Vegetable Oil Markets, and Contributing to Deforestation

In the April 10th workshop, Staff requested input on whether biomass-based diesel (BBD) demand is increasing oilseed demand or prices, or leading to deforestation. Staff correctly observed that the price trends around oilseeds are highly variable and subject to a wide range of economic, environmental, and geopolitical factors. Oilseed price alone cannot conclusively determine whether BBD demand is spurring ILUC or increasing emissions. ILUC's harm is caused by the conversion of land to agricultural use, with the products of that land back-filling commodities lost to biofuel production; that is to say, ILUC occurs when new demand for agricultural commodities caused by expansion of biofuels is satisfied by new production. The new demand for agricultural commodities is a simple, easily observable fact: millions of tons of feedstock is being consumed in the U.S. today that was not consumed 5 or more years ago. We have seen no evidence of disruption in the markets that formerly consumed current biofuel feedstocks, e.g. vegetable oil for human consumption, animal feed, soap production etc., which strongly suggests that these markets have found alternative suppliers to replace what was lost. This is clear evidence that biofuel policies are increasing global vegetable oil demand since the only plausible alternative source of lipids at commercial scale is vegetable oil. So long as the new producers of vegetable oil have a similar cost structure as the incumbent ones, this expanded supply would not be expected to significantly shift prices in related commodity markets.

[11] In the case of incineration, we assume that any energy production from the incinerator would be replaced by zero-carbon sources, meaning no net demand for energy would emerge from having the feedstock shifted to biofuel production. In practice, certification bodies would have to document this to certify a specific batch of fuel.

There is clear and direct evidence, however, that BBD is adding significant new demand to global vegetable oil markets, and that yields of U.S. oilseeds have not kept pace. Figure 1 shows per-acre yields of the primary oilseed grown in the U.S., soybeans.[12] Yields have been nearly flat across the 2016-2022 time period. Even if we take the lowest-yielding year in this range, 2018, as the starting point, yields have gone up by just 4.6% since then.

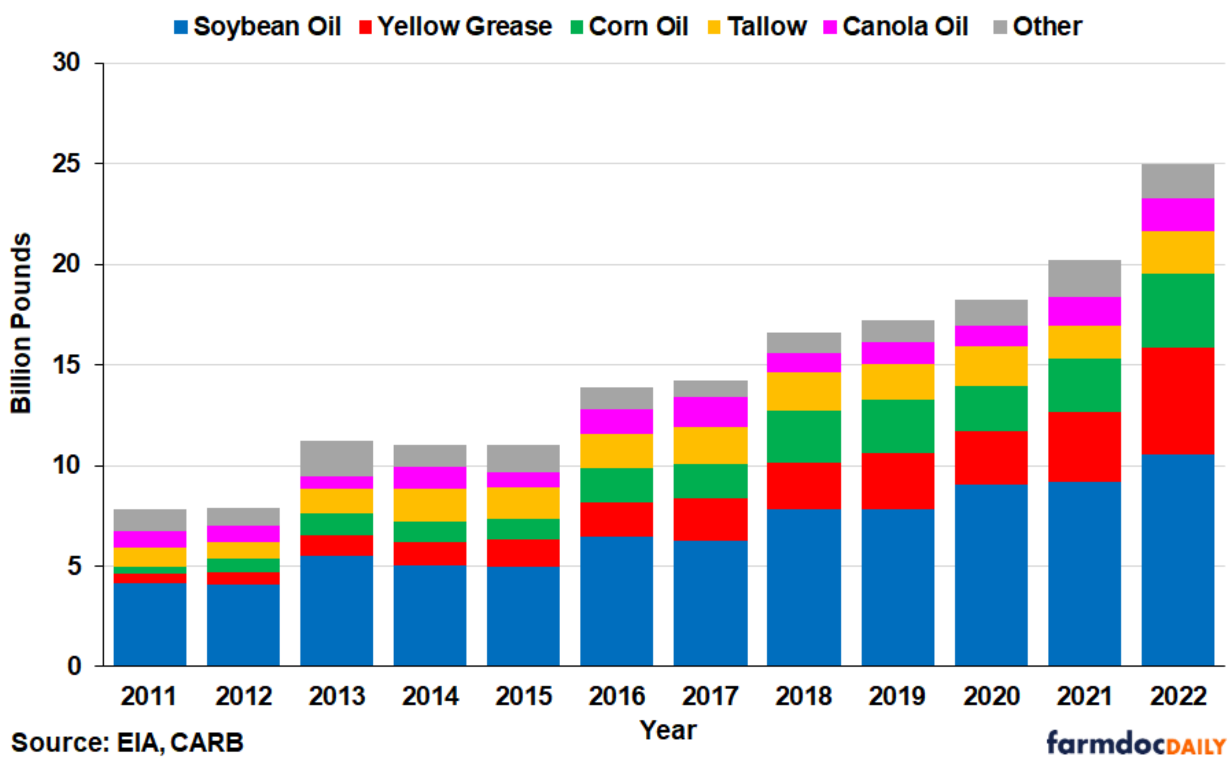


Consumption of vegetable oils as BBD feedstock, especially RD, has grown extremely rapidly over the same period.Total U.S. feedstock demand has grown from around 14 billion lbs in 2016 to 25 billion lbs in 2022, a 79% increase. 4-5 billion gallons of that increase was met by soybean and canola oils, the rest came from residues like tallow and yellow grease (primarily used cooking oil or UCO, a significant fraction of which is imported). Data presented by Staff at the April 10th workshop corroborate this impression; slide 55 showed an approximately 15% increase in global soybean oil production since 2016, compared to an approximately 50% increase in industrial demand for soybean oil, primarily from the U.S., over the same period. Even where waste and residue feedstocks are used, most of those feedstocks were previously used as inputs to other industrial processes like animal feed production or soap making. In most

[12] USDA National Agricultural Statistics Service (2024) https://www.nass.usda.gov/Charts_and_Maps/Field_Crops/soyyld.php

cases, these industrial consumers will turn to an alternative source of lipids for their process, such as vegetable oils. This means that even waste and residue oils have a non-zero ILUC impact, though typically a smaller one than crop-based oils.

Figure 5. Composition of Feedstock Usage for Annual Production of U.S. Biomass-Based Diesel by Volume and Major Feedstock Type, 2011 - 2022



Given the clear evidence of massive increases in demand for lipids, and equally clear evidence that this demand is not being met via yield increases or the emergence of novel low ILUC risk crops, one of two things must be true: either non-biofuel consumption of lipids has declined proportionately to the increase in demand from BBD production, or production has increased to compensate for the new demand. We can find no evidence global consumption of vegetable oils has significantly declined in the last 6-8 years - in fact it continues to increase with population and economic growth - nor is there any evidence that oilseed yields outside the U.S. have increased significantly faster than the historical trend. In short: there are few, if any, plausible alternative explanations for the increased supply of lipids that exclude significant ILUC.

Data on global rates of deforestation support the conclusion that biofuel demand is contributing to, though not solely responsible for, continued loss of forest. Forest tracking by the World Resources Institute showed a significant increase in aggregate global forest cover loss starting in 2016, roughly the start of significant BBD capacity expansion in the North American market;

deforestation has remained above the pre-2016 trend since then.[13] Indonesia, a focal point for biofuel-driven deforestation in the 2000's and 2010's, has seen an increase in rates of deforestation since 2021. Clearly, biofuels are not the sole cause of deforestation, but it is equally clear that additional demand from biofuel growth exacerbates this harmful trend.

Sustainability requirements and preferences for waste or residue feedstocks are insufficient to protect against this risk. The LCFS already provides substantially higher incentives for wastes and residues than for crop-based fuels due to their lower CI scores. Despite this preference, the amount of crop-based BBD has more than doubled since 2021.[14] While it is too soon to tell what impact the sustainability certification requirements will have on feedstock availability, comments from U.S. biofuel producers and agricultural companies typically claim that standard industry practices meet or exceed the environmental metrics required under the proposed sustainability certification. We have seen no evidence to indicate that the proposed sustainability certification will reduce the pool of potential feedstock available to the California market to the point where it impedes continued growth of BBD production. This is to say, the proposed combination of preferences for waste-based fuels and sustainability certification requirements is likely to have a very limited impact on the actual supply of feedstock for biofuel production. While they may exclude isolated cases of high environmental impact, they are unlikely to represent a significant change in market dynamics compared to the *status quo*. Given that the *status quo* is characterized by problematically low LCFS credit prices, unsustainable rates of growth in BBD production, and significant concerns about ILUC impacts, alternative approaches may deserve serious consideration.

ILUC is, at its core, a problem of aggregate demand for agricultural commodities. Biofuel demand for vegetable oils or other agricultural commodities was nearly zero until the mid-2000's, but has grown rapidly since then. The additional production used to satisfy the demand from this new use came, in part, from expansion of cultivated area. Waste feedstock preferences and sustainability certification can ensure that biofuels use the highest-quality, lowest-GHG feedstock available, however not all increased demand is satisfied by high-quality, low-GHG feedstock. The only way to limit these harms is to restrict the total demand growth to a level that can be satisfied without requiring additional land conversion. A cap on specified types of feedstock could achieve this.

[13] World Resources Institute (2024) https://research.wri.org/gfr/latest-analysis-deforestation-trends
[14] CARB Quarterly Data Summary Spreadsheet. https://ww2.arb.ca.gov/sites/default/files/2024-04/quarterlysummary_Q42023.xlsx This assumes that the vast majority of the RD-Other category comes from canola or other crop-base oils.

The Proposed ILUC Approach for Un-Specified Feedstock Types is Inadequately Protective Against ILUC Risk, Methodologically Unsound, and Could Benefit Imported Fuels Compared to Domestic Ones

At the April 10th workshop, Staff discussed revisions to the current LCFS approach around ILUC. In particular, Staff noted that the Land Use Change adjustment values specified in Table 6 of the regulation are specific to certain geographical areas. Pathways using feedstock from areas not covered by Table 6 have been submitted for public comment in recent months, and Staff sought input on how these should be handled in the future.

Slide 65 indicates that in cases where a pathway uses feedstock not covered by Table 6, Staff would make a case-by-case determination based on empirical sub-national production data. The use of land cover data, including remote sensing or satellite imagery was proposed as one option for obtaining the required empirical data. Few details on the nature of this analysis were provided, and it is difficult to effectively evaluate the efficacy of such a solution without knowing more about the methodology to be employed in making these determinations.

At a conceptual level, however, ILUC analysis is not amenable to purely, or even primarily empirical solutions. ILUC cannot be directly measured, because it is a phenomenon that works indirectly, through global markets. While sensors can provide empirical data to show that a given parcel of land was cleared for cultivation, there is no empirical way to conclusively identify why that clearance, or any land use change decision, occurred; not all land clearance is due to ILUC. More importantly, many ILUC impacts occur in different regions, or different countries than the activity that causes them. For example, reduced U.S. soybean oil exports results in un-met demand for vegetable oils in the countries that formerly received those exports. The land use change that occurs because of reduced U.S. soybean oil exports may occur in South America, Asia, Africa, or elsewhere. A sub-national data analysis will not capture impacts outside of its geographic scope.

Beyond the geographic limitations, empirical approaches cannot effectively quantify ILUC. ILUC is assessed through consequential analysis, typically comparing the outcomes or expected outcomes of a given project against a counterfactual scenario in which the project did not exist. Counterfactual scenarios, by their very nature, do not exist and so cannot be empirically assessed. The emphasis on empirical analysis therefore conflicts with the methodologies needed to effectively assess ILUC.

The assessment of ILUC, like any life cycle analysis, requires making certain analytical assumptions related to system boundaries, allocation methodology, additionality determinations, and establishment of counterfactuals. Most of these assumptions do not have a purely objective basis on which to make them; there is no single objectively correct approach to setting a system boundary or allocating impacts among coproducts.[15] Allowing case-by-case empirical analysis creates an opportunity for different assumptions to be used by different applicants, leading to pathway certified carbon intensities that are not comparable and create an unequal playing field for LCFS market participants. Establishing a consistent model-based methodology ensures that pathway applicants cannot leverage favorable analytical assumptions to gain a competitive advantage. This is especially important given that the proposal would require pathways using feedstocks that are included on Table 6 to continue using those ILUC values; foreign producers or those using a novel feedstock could obtain a competitive advantage from the non-comparable and probably less strict empirical methodology.

The Existing ILUC Methodology is Outdated, Unsuited For the Current Market, and Inadequately Protective Against ILUC Risk

The proposed new approach for ILUC assessment and risk mitigation for feedstocks not specified in Table 6 is not only inadequate in and of itself, but it is built upon the assumption that the existing ILUC approach is adequate for feedstocks that appear on Table 6. We have discussed, in depth, the reasons why the current ILUC approach is inadequate in previous comment letters, but will summarize them here.

1. The GTAP-AEZ modeling used to create the Land Use Change adjustment values in table 6 was conducted in 2015 and 2016, making it almost 10 years old. Not only have researchers significantly improved our understanding of the mechanisms of ILUC, but a much longer and higher-quality data record now exists, and there have been significant changes in markets, technology, geopolitical conditions, and agronomic behavior over the last decade. ILUC is a phenomenon for which analysis must be regularly updated.
2. While it may have been state of the art at the time, recent research has highlighted significant structural flaws in the version of GTAP used when the analysis for Table 6 was completed.[16] These flaws tend to bias the results toward underestimation of ILUC impacts. The lead researcher from CARB's modeling effort that developed the values in Table 6 submitted a comment to the 45-day docket corroborating the conclusion that the version of GTAP used was flawed and a new approach should be adopted.[17]
3. The analysis used to develop Table 6 simulated a "supply shock" based on approximately 1 billion gallons of new demand for BBD feedstock. Current U.S. BBD

[15] See: Murphy (2023) *Making Policy in the Absence of Certainty: Risk-Aware Consideration of ILUC Estimates for Biofuels* for a deeper discussion. https://www.youtube.com/watch?v=eT06-vw0Fnw
[16] E.g. Malins, *et al.* (2020) https://www.sciencedirect.com/science/article/abs/pii/S0959652620307630 and Berry, *et al.* (2024) https://www.arb.ca.gov/lists/com-attach/6987-lcfs2024-AXVUPQNgUWsDa1AP.pdf
[17] O'Hare (2024) *Low Carbon Fuel Standards Amendments.* *https://www.arb.ca.gov/lispub/comm/iframe_bccomdisp.php?listname=lcfs2024&comment_num=7063&virt_num=380*

production capacity is several times that amount already, meaning that the scenario analyzed does not reflect current or future market conditions. Average per-gallon ILUC impacts like those reflected on Table 6 will tend to increase as total volumes of biofuel increase, because as waste and residue sources are tapped out, a greater fraction of total production will be met by crop-based sources. Additionally, as cultivated area expands over time, high-yielding areas will typically be brought into cultivation first, meaning that as total demand increases, each additional unit of production will, on average, require more land to produce.

Taken together, these factors indicate that not only are the ILUC values outdated and almost certainly inaccurate, but they are likely to be underestimates of actual ILUC impact. While it is still likely that most BBD credited under the LCFS to date is lower-carbon than petroleum over its full life cycle, it is likely that many pathways - especially those using crop-based feedstocks - do not actually yield the GHG benefits their CI scores would indicate. This mismatch between certified CI scores and actual GHG impacts is likely to increase, since per-gallon ILUC effects would tend to increase as total vegetable oil production increases. This leads to LCFS revenue being given for emissions benefits that do not actually exist. Beyond that, it complicates effective policy planning and evaluation. For example, the stated rationale for rejecting the LCFS alternatives that cap or otherwise limit BBD includes foregoing the GHG reductions that BBD could provide. CARB's estimates of GHG reductions, however, are based on the pathways certified CI scores for existing biofuels. Given that the ILUC adjustments included in those scores are clearly inaccurate, and likely to be underestimates, the GHG benefits associated with those fuels are likely to be less than anticipated.

Other Issues Raised at the April 10th Workshop

In addition to the in-depth discussion of LCFS market modeling, new compliance trajectories, and feedstock sustainability, a few other issues were raised. We address them here.

Historical Analysis of Correlation Between LCFS Credit Price and Gas Prices Does Not Effectively Project Future Gas Price Impacts

On slide 11 CARB staff presented a figure drawn from a consulting report by the economic consulting firm Bates White that shows trend lines for LCFS credit prices and retail gasoline prices. These lines show no visual correlation and staff repeated language from the consultant's report that "LCFS program price effect at the pump is not a significant driver of retail fuel prices in California".

It is true that an analysis of LCFS program data from 2010 through the present would show little if any visually detectable correlation between LCFS credit prices and retail gasoline prices. This conclusion, however, does not hold into the future. Per-gallon LCFS cost impacts can be estimated by multiplying the amount of credits or deficits per gallon times the relevant LCFS credit price. Per-gallon credit generation is a function of the target level, the CI scores of the fuel, and several constants including EER and fuel energy density.[18] During most of the period covered by this analysis, the LCFS targets were extremely low. Targets were effectively frozen at 1% reduction from baseline through 2015 due to litigation, and did not hit 10% until 2022. Given these low targets, the per-gallon deficit generation would be extremely low as well, meaning that any impact from the LCFS would likely be lost among the significant natural variability in retail gasoline prices. Theoretically, there is no reason to think that costs on petroleum fuels, even if modest, wouldn't be passed along to consumers, and emerge in an appropriately structured updated statistical analysis.

It is not appropriate to interpret the Bates White analysis as supporting the conclusion that the LCFS will have no price impacts in the future; since program targets are increasing, the per-gallon deficit generation will increase as well and with it, a commensurate increase in costs associated with LCFS deficits.

It should also be noted that even though the LCFS is expected to have a price impact in the future, this impact is expected to be smaller than normal seasonal gas price variability for most of this decade at least, and the benefits the program provide via slowing climate change, improving air quality, supporting the transition to renewable energy, and making critical investments in disadvantaged communities far outweigh the costs in most analyses. UC researchers evaluated total transportation costs associated with the transition to clean fuels and electric vehicles, including the costs of the LCFS as part of our study on how California's transportation system can achieve carbon neutrality.[19] We found that by 2030 the lower fuel and maintenance costs of EVs more than offset the higher costs of vehicles and fuels for legacy vehicles; the LCFS is a critical part of the portfolio of policies that supports electrification. Indeed, diversification of transportation fuels, and appropriately accounting for externalities like GHG emissions, are critical to decarbonization, greater societal benefit, and lower transportation costs in the longer run.

E15 May Offer the Opportunity to Mitigate Gas Price Increases and More Rapidly Reduce Emissions

On slide 52, Staff asked whether E15 should be considered to help reduce gas cost impacts. Our modeling has explored the possibility of shifting to E15 as the default fuel for spark-ignition engines.[20] The risks associated with an E15 standard are primarily focused around aggregate

[18] See Section 95486.1 of the LCFS regulation text
[19] Brown, *et al.* (2021) *Driving California's Transportation Emissions to Zero by 2045* https://escholarship.org/uc/item/3np3p2t0
[20] See Brown *et al.* (2021), Ro, *et al.* (2023), and Murphy & Ro (2024)

demand for agricultural commodities as feedstock, particularly corn. While significant expansion of total corn ethanol production in the U.S. could lead to significant ILUC or other impacts, the anticipated decline in gasoline consumption as the light-duty vehicle fleet shifts to EVs offers an opportunity to extract additional value out of ethanol with minimal risk. So long as the shift to an E15 standard is timed to ensure that no significant increases in total demand for ethanol occur, or that demand is satisfied by fuels and feedstocks that present low risk of ILUC, an E15 standard can be compatible with California's goal of carbon neutrality by 2045.

Adopting an E15 standard would provide two notable benefits. First, it would rapidly displace a small but significant amount of petroleum from California's fuel pool. While corn ethanol offers only modest GHG benefits when displacing petroleum, the scale of California's transportation sector means that even relatively small shifts in fuel CI can yield significant GHG savings. Second, by reducing the amount of petroleum consumption, California may be able to insulate itself from oil price volatility and possibly begin driving down petroleum prices due to reduced structural demand.

Unresolved Issues Point to Need for Additional Rulemaking in the Near Term

From the start of the workshop and engagement process that led up to this rulemaking, Staff were clear that the scope would be strictly limited in order to allow timely and efficient adoption of changes that could stabilize the LCFS credit market and help strengthen the LCFS credit price. The workshops, engagement opportunities, and discussion materials circulated since then have reflected this agenda. Given the significant decline in LCFS credit prices, this focus on corrective measures is understandable.

The limited scope, however, meant that many critical and complex structural topics that, when fully explored, might offer avenues to improve the efficiency, resilience, and effectiveness of the LCFS as decarbonization proceeds were excluded from this rulemaking. These include, but are not limited to, consideration of updated EERs, updating how the regulation addresses ILUC impacts, addressing appropriate crediting from fossil fuel displacement in a transitioning fleet, treatment of interactions or potential double-counting with other climate programs, harmonizing LCFS protocols with other jurisdictions that have similar programs in place or coming online, preparing for radical LCFS credit market shifts anticipated in the 2030's as program revenues begin declining due to reduced gasoline consumption, expanding the LCFS to cover air, water, and rail fuels, and integrating vehicle or transportation-system effects into fuel CI assessment, differentiation between so-called "bridge" fuels and those with the capacity to achieve carbon neutrality, etc. As discussed in earlier sections of this comment, several of these issues have demonstrated actual or potential capacity to negatively affect the LCFS and/or progress toward California's climate, environmental, and equity goals within the next 5-10 years. The other issues deserve careful consideration and the opportunity for public discussions in a forum that includes stakeholders from a variety of perspectives and LCFS program staff.

It is especially important in the transportation fuel space to make policy changes as early as possible, in order to avoid a situation that requires precipitous action that may create stranded assets, excessive fuel price volatility, or erode policy certainty about the LCFS market. The LCFS has in the past conducted major rulemakings following the release of the Scoping Plan; if past patterns hold this would imply the next significant LCFS rulemaking in 2028. By that time, failure to address some of the issues listed above could lead to another destabilization of LCFS credit markets. While many of these issues are complex and will take significant time and resources to address, most are amenable to solutions that can be gradually implemented, to minimize disruption. Waiting until a crisis emerges increases the chance that precipitous, disruptive change will be required.

CARB should commit to a follow-up LCFS rulemaking, without any limitations to its scope, at the earliest possible opportunity.

Thank you again for the opportunity to provide comments on the proposed amendment package. We appreciate the discussion this process has fostered so far and look forward to continuing our dialog through the coming year. We attach to this submission copies of the three recent reports from our research group related to research and modeling the LCFS, they are also available at the links cited in this letter. If we can offer any additional assistance or clarify any of the material in this comment, please do not hesitate to reach out to Colin Murphy by email at cwmurphy@ucdavis.edu.

Signed,

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