UC DAVIS
Institute of Transportation Studies

21 April, 2025

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 Proposed Amendments to the Low Carbon Fuel Standard

Dear LCFS Team:

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 (ITS-Davis) has been engaged in research, policy analysis, and technical assistance relating to the LCFS since it was first developed, over 15 years ago. Since then, the LCFS 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 is intended 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]

The 3rd 15-day comment package released on April 4th ("3rd 15 day package") addresses several areas identified as needing additional clarification by the Office of Administrative Law. Resolving these should conclude the rulemaking process that was begun well over 2 years ago. This rulemaking has sought to address persistently low credit prices that present a significant obstacle to California's efforts to achieve carbon neutrality by 2045. Most, though not all, of the changes proposed in the 3rd 15 day package make non-substantive changes from the package of amendments presented to the Board on November 8th, 2024. On the whole, they do not significantly alter the impression of the total effect of the proposed package of amendments that we presented in our comment letter submitted on 16 October, 2024: the proposed amendments are likely to provide some incremental, and likely transient upward pressure on prices but the fundamental credit oversupply facing the market will remain and additional reforms will be necessary to secure the LCFS for long-term stability.[2]

These comments are presented in the spirit of ITS-Davis's mission to bring science into the policy process. Neither UC Davis nor ITS-Davis seek a specific policy outcome; these comments are offered to help California meet its climate, environmental, and equity goals.

[1] SB 32 (Pavley, Chapter 249, Statutes of 2016), AB 1279 (Muratsuchi, Chapter 337, Statutes of 2022)
[2] See: Our 16 October 2024 comment submitted by in response to 2nd 15 day amendment package. https://www.arb.ca.gov/lists/com-attach/8069-lcfs2024-B3JcOQNdVmFSNVch.pdf

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Modifications to § 95482

Proposed modifications to this section would allow hydrogen produced by steam methane reformation (SMR) with accompanying carbon capture and sequestration (CCS) to count toward the 80% renewable hydrogen requirement for 2030 and be excluded from the planned 2035 phaseout of hydrogen made by SMR of fossil fuels. This change would mean that hydrogen made by SMR+CCS systems would receive approximately equivalent treatment under the LCFS as renewable hydrogen such as that made from electrolysis of water using renewable energy, though the carbon intensity (CI) score assigned to each form may differ. This approach aligns with the LCFS' existing focus on carbon intensity, rather than production characteristics, as the primary metric by which fuel pathways are assessed, however it would put the program out of step with other State and Federal policies, as well as several other provisions within the LCFS.

Multiple policy frameworks adopt a clear distinction between renewable and non-renewable sources of energy, including, and of particular relevance to the LCFS, the Federal Renewable Fuel Standard (RFS), and the State Renewable Portfolio Standard. Both policies distinguish between fossil fuels, for which the supply is finite and non-renewable over policy-relevant timescales, and renewable fuels such as wind, solar, and biomass (or biomass only in the case of the RFS), that can be used over many years without depletion. The LCFS focuses on life cycle carbon intensity as its primary metric for evaluating fuel pathways, however it offers differing treatment to renewable pathways in several critical ways. For example, renewable electricity generation like wind or solar is assumed to have a carbon intensity of zero (despite ample evidence from life cycle assessment literature that there is a small, but non-zero GHG impact from such sources[3]), rather than going through individual pathway certification like other fuels. To the extent that the proposed changes would extend treatment typically reserved for renewable energy systems to a non-renewable one, it may add complexity to the challenge of navigating California's climate policy portfolio.

There are meaningful technical and operational differences between hydrogen production from electrolysis of renewable electricity, and that made by SMR with or without CCS. Appropriately designed, permitted, operated, and regulated SMR+CCS systems can reduce GHG emissions compared to conventional SMR. However, they are subject to operational constraints like access to geological sequestration sites, and dependence on large quantities of inexpensive methane (e.g., fossil "natural" gas). Similarly, their use is associated with a different slate of environmental impacts and risk factors - e.g., fugitive methane leakage or CCS well failure - that do not apply to electrolytic hydrogen production. These differences must be recognized and appropriately considered if these approaches to GHG reduction can be leveraged to maximize their potential value. The proposed revisions in this section would allow SMR of fossil gas with CCS to be counted against a requirement for "renewable" approaches to hydrogen production,

[3] E,g, Smith, Brittany L., Ashok Sekar, Heather Mirletz, Garvin Heath, and Robert Margolis. 2024. An Updated Life Cycle Assessment of Utility-Scale Solar Photovoltaic Systems Installed in the United States. Golden, CO: National Renewable Energy Laboratory. NREL/TP-7A40-87372. https://www.nrel.gov/docs/fy24osti/87372.pdf.

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which could constrain the ability of the LCFS, or regulatory programs that adopt the LCFS' approach, to recognize and appropriately reflect the meaningful differences between SMR+CCS systems and electrolytic ones (or other renewable approaches to hydrogen production). Maintaining the distinction may be important for LCFS or other climate policies to provide levels of support to each method that are proportional to the GHG or other environmental benefit they provide. Weakening the incentive for non-fossil sourcing for hydrogen production could lead to the risk of stranded assets in the future, given California's commitment to move away from fossil fuel use as much as possible.

Modifications to § 95483

We note that the proposed changes to this section extend the current treatment of a significant fraction of LCFS credit revenue from residential EV charging, which is largely used to fund incentives for MD and HD EV purchase. Given the withdrawal of the waiver application for the Advanced Clean Fleets (ACF) rule, there is a profound need for California to deploy additional support for MD and HD ZEV deployment; while the revenue from the LCFS is unlikely to yield the same net effect as ACF, it can contribute to a portfolio of policies that fill this gap.

Modifications to § 95486.3 and § 95486.4

Changes to this section remove the cap on revenue from infrastructure credits for unused fueling capacity at hydrogen refueling stations, which was previously set at:

> "...the difference between 1.5 times the initial capital expenditure, not including on-site generation, land, working capital, or off-site facilities, reported pursuant to section 95486.3(a)(6)(C)1. and the sum of total grant revenue or other external funding before the station is both approved and operational, pursuant to section 95486.3(a)(6)(C)5. and 6. in the prior quarter"[4]

This revenue cap remains in place for capacity credits for unused DC-Fast charging (FCI) stations.

Supporting the deployment of ZEV fueling infrastructure in advance of vehicle fleet transformation aligns with best practices suggested by current research in this space.[5] However, it is not clear why the cap was removed for HRI but not FCI; the differing treatment of two generally similar forms of ZEV fueling infrastructure may cause confusion among stakeholders. We note that the Office of Administrative Law did not identify issues related to the per-station cap on HRI revenue as problematic or needing clarification in their decision to return the

[4] This language was removed from § 95486.3 (a) (4) (H) and § 95486.4 (a) (4) (I) but remains in § 95486.3 (b) (4) (H) and § 95486.4 (b) (4) (I). Source: Attachment A-2.1 *Proposed Final Regulation Order* https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/atta2.pdf
[5] Brown, A.L., Sperling, D., Austin, B., DeShazo, J.R., Fulton, L., Lipman, T., Murphy, C., et al. 2021. Driving California's Transportation Emissions to Zero. https://doi.org/10.7922/G2MC8X9X

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proposed amendments for additional clarification.[6] As such, we question why this change in policy was suggested at this late phase of the rulemaking, after the board had considered and voted to approve the amendments on November 8th.

In addition to the potential confusion resulting from these changes, they may lead to a small handful of projects claiming a disproportionate share of infrastructure capacity credits, resulting in credit revenue flowing in ways that do not support California's ZEV goals. The total number of HRI and FCI credits are each capped at a quantity equal to 2.5% of prior year deficits in any given year, if issued and anticipated HRI and FCI credits would exceed that cap, no new pathways in the category exceeding the cap would be approved. That is to say, if the HRI program is utilized to its fullest extent and supports enough stations to reach the cap, then no additional stations can take advantage of the HRI provisions within that category for a given year. Imposing the 1.5x capital cost cap on total HRI revenue helped ensure that the HRI program would be able to support a greater number of stations, and support the State's goals around widespread ZEV fueling infrastructure availability. If a low utilization station had received total credit value that exceeded the limits as described above, they would effectively be removed from the program and the space under the cap that station had previously occupied would be freed up for another station. This helped ensure that the HRI and FCI provisions supported the deployment of a large number of stations, and created a strong incentive to increase the utilization of existing stations. The changes proposed in the 3rd 15 day package would allow stations to continue receiving HRI credits for the full duration of these provisions and potentially exclude new stations from taking advantage of these provisions.

Beyond this, there is no clear reasoning given why a particular station should receive capacity credits in excess of the difference between capital cost and received grant or incentive revenue. No analysis was presented in the ISOR or any associated LCFS documents that we could find during the rulemaking process that justified this level of support as being necessary or appropriate for the purpose of expanding ZEV refueling infrastructure. Providing 1.5 times the capital cost (less other incentives) offers a sizable incentive for the provision of this type of ZEV fueling infrastructure, considering that such stations will also receive revenue from regular LCFS credits, RFS incentives, sale of fuel and possibly other sources. Work by ITS-Davis researchers (though conducted while at a previous institution) evaluated the projected revenue available to light-duty HRI and FCI stations and demonstrated that these could plausibly receive capacity credits with total value at several multiples of station capital cost.[7]

Without additional analysis or justification, it is difficult to understand how or why this level of incentive is appropriate for the purpose of supporting ZEV fueling infrastructure expansion. The

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[6] Office of Administrative Law (2025) Decisions of Disapproval of Regulatory Action. State of California. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/disapproval_decision.pdf

[7] These were submitted to the public comment docket for the 2018 LCFS rulemaking here: https://www.arb.ca.gov/lists/com-attach/256-lcfs18-AmxcPwd+ByADYlUw.zip Reference to these comments is a citation to previous work. Neither Nextgen California or any related entity contributed to this letter (dated Apr 21, 2025) and nothing herein should be taken as indicating any statements or expressed positions on their behalf.

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analysis and concerns presented in that 2018 letter have never been clearly addressed by CARB or related stakeholders; we still lack a transparent statement of capital and operational costs for the types of stations the HRI and FCI provisions seek to support, and cannot evaluate whether the level of support provided by these provision is appropriate or efficient. Unrestricted HRI or FCI crediting could lead to windfall profits for the station developer, in which a low-utilization station could receive substantial credit revenue, potentially in the hundreds of thousands of dollars per year, derived predominantly from charges on petroleum gasoline paid by California consumers, even after the station has fully recouped investment and operational costs. Removing this cap without analysis or justification increases the risk that significant amounts of LCFS credit revenue will be spent in ways that provide little benefit to either California's long-term decarbonization goals or the Californians themselves.

Modifications to § 95488.3

This section modifies how the LCFS will account for indirect land use change impacts, especially those for which a pre-calculated value is not presented in Table 6. These changes recognize a clear and important problem that needs to be addressed in order to allow the LCFS to continue to effectively support the decarbonization of transportation fuels. Land use change (LUC), especially market-mediated land use change (known as indirect land use change or ILUC) associated with biofuels can cause significant GHG impacts; ignoring or underestimating these impacts increases the risk that fuels' actual GHG impacts will exceed their assessed CI score. In some cases, per-gallon GHG impacts of ILUC can be quite large, potentially higher than the carbon intensity score of the fuel itself or the petroleum equivalent it seeks to displace.[8] Given that CARB has received LCFS credit pathway applications for fuels using feedstocks not reflected in Table 6, it is important to establish alternative protocols for evaluating their GHG impacts, including ILUC. The proposed language presented in the 3rd 15 day package makes steps in this direction. However, it leaves some significant areas of uncertainty and creates a potentially severe risk of inaccurate ILUC assessment. We identify three areas of particular concern - applicability of the definition of "conservative" used elsewhere in the LCFS, lack of clarity regarding the term "modeling framework," and overreliance on satellite imagery; we will discuss each of these in turn.

First, it is unclear what is meant by "conservative" as it is used in § 95488.3 (d) (2). The term is generally defined in § 95481 as "reducing the estimated GHG reduction benefits of an operation or utilizing methods and factors that over-estimate energy usage or carbon intensity (90th percentile or highest value)" however, it's not clear how this would be operationalized in the context of ILUC assessment. The conceptual basis for this guidance - to choose estimates that typically imply higher assessed CI scores - is clear and appropriate, given the asymmetric risk dynamics around ILUC estimation. A preference for overestimation rather than underestimation

[8] E.g. Table 7.7-1, US EPA, 2023. Model Comparison Exercise Technical Document (No. EPA-420-R-23-017). https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1017P9B.pdf

of ILUC provides greater protection against stranded assets or significant and functionally irreversible (on time scales relevant to addressing climate change) GHG emissions.[9]

While the idea of using the 90th percentile estimate is conceptually clear, it is difficult to operationalize in the context of ILUC modeling, however. The problem is that there is no way to directly sense or measure the ILUC impact of a given fuel+feedstock combination. Any assessment of ILUC is, by necessity, a modeled estimate and therefore based on a set of modeling and analytic assumptions, subject to the limitations imposed by the modeling framework and analytic tools. Quantitative empirical data are measurable, and so long as the measurement instrument is free from systematic bias, a set of measurements could describe underlying characteristics of interest given enough measurements. The statistical tools we have for assessing the validity and representativeness of a sample are often predicated on independent and unbiased measurement error terms.[10] When this is the case, the range of potential outcomes and the distribution of outcomes can be assessed, which allows the identification of a 90th percentile outcome: it is explicitly defined via mathematical formulae. This distinctly contrasts with the modeling tools used to assess ILUC, for which the range of potential outcomes and distribution of results within that range is dependent on the model and input parameters being used. Models are unlikely to have unbiased, independent error terms because the assumptions made to allow a given model to function are likely to bias modeled results towards a certain outcome. This means that the 90th percentile standard articulated in the definition of "conservative" cannot assure a reasonable chance of accuracy for modeled results in the same way that it can when applied to measurements or empirical data.[11] The 90th percentile outcome, *as identified by any given model*, may be below the actual impact (if such could be conclusively determined). More plausibly, the 90th percentile outcome according to one model may be below the 1st percentile outcome of a different model that is based on equally credible assumptions or methodology. There is no empirical measurement of net outcomes possible to calibrate such models, so the range of outcomes can be quite large, as found in the US EPA model comparison analysis.[8] Given that some studies have found that the GTAP model underestimates land use change impacts from biofuels under plausible real-world conditions,[12]

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[9] See this explanatory video (https://www.youtube.com/watch?v=eT06-vw0Fnw&t=3s) and this blog (https://its.ucdavis.edu/blog-post/making-policy-in-the-absence-of-certainty-biofuels-and-land-use-change/) for more detail on these risk dynamics.
[10] This is not to say it requires measurement tools that are free from any error at all, but rather that errors are uncorrelated with respect to each other or external parameters.
[11] Models can, in some circumstances, be calibrated using past results, however the calibration remains accurate only so long as the modeled conditions in the underlying system remain relatively stable. In the case of ILUC, we know that climate change, geopolitical forces, and advancing technology are causing significant change on the forces affecting land use decisions around the world.
[12] 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
We also note that the lead investigator on the 2016 effort to develop the ILUC estimates in Table 6 submitted a comment indicating that GTAP estimates likely underestimate actual GHG impacts
https://www.arb.ca.gov/lispub/comm/iframe_bccomdisp.php?listname=lcfs2024&comment_num=7063&virt_num=380

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even a 90th percentile outcome from a set of GTAP-AEZ modeling that used randomized sets of plausible input parameters could substantially underestimate actual GHG impacts from biofuels.

Second, § 95488.3 (d) (2) states that this “conservative” value shall be calculated based on the “same modeling framework” as in § 95488.3 (d) (1), which describes the basic function of the GTAP and AEZ-EF models. It is not clear what the “same modeling framework” means. This could be interpreted to require the use of the same GTAP and AEZ-EF models as were used to provide the LUC adjustment factors adopted in 2016, updated versions of the same model, or equivalent models that adopt the same basic structure - using an economic equilibrium model to determine land changes and an emission factor model to quantify GHG emissions resulting from such changes.

As a term of art used within the research and modeling community, the term “modeling framework” would typically, though not exclusively, be used to describe a conceptual or methodological approach, but not a specific model or version. Multiple models could be described as sharing a modeling framework if they use similar definitions or terminology, data sources, or methodological approaches. When discussing models like those referenced in § 95488.3 (d) (1), we would suggest that the “same modeling framework” requirement is most reasonably interpreted to mean an economic equilibrium model for assessing land use changes and a land use change emission factor model to quantify GHG impacts of such changes. This could mean that models other than GTAP and AEZ-EF would satisfy the “same modeling framework” requirement, though they would need to align their system boundary and other analytic assumptions with those from the earlier CARB analysis where possible, to allow direct comparison with the results presented in Table 6.

Interpreting § 95488.3 (d) (2) to require the use of GTAP and AEZ-EF, or to specify even greater methodological overlap with the 2016 analysis that led to the values presented in Table 6 would limit the analytical tools available to CARB for the purpose of estimating ILUC impacts of biofuels and force the program to rely on existing models regardless of their performance. The scientific discussion includes arguments that the GTAP model in particular, has been shown to yield results that underestimate ILUC impacts under many sets of inputs.The U.S. EPA found GTAP estimates, especially for lipid-based biofuels (such as biodiesel and renewable diesel), to be at the low end of the range of estimates they found from several ILUC models.[8] We will discuss the implications of overestimation and underestimation of ILUC emissions later in this section.

ILUC modeling is a continually evolving field, due to changes in methods as well as on the ground. A wide range of economic, ecological, and social forces impact land use decisions and reflecting these in a computational framework is a complex challenge that has not been conclusively solved by researchers, yet. The inter-model comparison exercise conducted by the U.S. EPA showed that even though estimates of ILUC impact for a given feedstock/fuel combination could vary widely (as they did with soybean oil biodiesel), multiple models and modeling frameworks can coalesce around a relatively smaller range of estimates (as they did with corn ethanol) as well. It is entirely appropriate to set robust standards for analytical rigor

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and to ensure that results from different models are comparable in a regulatory environment. Limiting to any single modeling framework (including a pair of models as in the GTAP and AEZ-EF case) may overly restrict the set of tools CARB or other stakeholders could use to address this challenge. This is especially problematic when the limitation forces the use of a model (GTAP) that has undergone critique and shown a tendency towards underestimation of ILUC impacts, especially given the intent (expressed via the definition of "conservative") is clearly to lean in the opposite direction.

Third, § 95488.3 (d) references satellite imagery data as a primary source to support estimates of land use change impact. Satellite imagery of land cover is a valuable source of such data and routinely utilized in this field. It is important to note, however, that satellite imagery has limitations that impact how it might be used for LCFS ILUC estimation. Land imaging satellites directly sense electromagnetic radiation, and use a variety of mathematical methods to resolve signals carried by such radiation into estimates of the extent of different types of land cover. There is both underlying measurement error in such imagery, as well as continued debate over the most appropriate methods for assigning land classifications based on satellite imagery.[13]

Estimates of changes to land use or cover based on regional or continental satellite data may also overlook impacts that occur elsewhere. ILUC is a global phenomenon; changes in biomass availability or cost may induce changes in land use in distant markets. Existing research has identified the linkage between U.S. or European biofuel consumption and deforestation in Southeast Asia, for example.[14] A 2024 CA State Auditor's report reinforced this conclusion.[15] A hypothetical pathway using novel feedstock (i.e. not represented in Table 6) grown in the U.S. could provide high-quality satellite imagery covering the entirety of North America, and yet this would still not cover the geographies that may be affected by land use change resulting from the use of this fuel. The absence of land use change impacts discernible via regional satellite imagery may mean that such impacts are occurring elsewhere, or that other factors are inducing unrelated changes that obscure the LUC signal from biofuel development. As such, satellite imagery alone, especially when confined to the region in which feedstock is cultivated, is an inadequate protection against ILUC risk.

More importantly, however, satellite imagery can only show things as they exist today or in the past. In many scenarios relevant to LCFS support for biofuels, and indeed in the modeling

[13] E.g., Kupidura, P. (2019). The Comparison of Different Methods of Texture Analysis for Their Efficacy for Land Use Classification in Satellite Imagery. *Remote Sensing, 11*(10), 1233. https://doi.org/10.3390/rs11101233 , Schepaschenko, D., See, L., Lesiv, M. *et al.* Recent Advances in Forest Observation with Visual Interpretation of Very High-Resolution Imagery. *Surv Geophys* 40, 839–862 (2019). https://doi.org/10.1007/s10712-019-09533-z,

[14] E.g., L. Reijnders, M. A. J. Huijbregts, Palm oil and the emission of carbon-based greenhouse gases. Journal of Cleaner Production 16, 477–482 (2008). https://doi.org/10.1016/j.jclepro.2006.07.054
J. Glauber, C. Hebebrand, Food versus Fuel v2.0: Biofuel policies and the current food crisis | IFPRI : International Food Policy Research Institute (2023). https://www.ifpri.org/blog/food-versus-fuel-v20-biofuel-policies-and-current-food-crisis.

[15] California State Auditor (2024) *Tropical Forest Risk Commodities* https://www.auditor.ca.gov/reports/2023-129/

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framework underpinning current ILUC modeling, the ILUC changes most relevant for pathway certification purposes are the ones that have yet to occur, because novel fuel production pathways are unlikely to be present at their full scale when a given fuel+feedstock combination is first certified. That is to say, the increased demand for feedstock that would drive ILUC may not have occurred at the time satellite imagery was collected for the purpose of pathway certification. Alternative fuel producers often seek certification of a pathway based on data from pilot plants or other first-of-kind commercial deployments. If such a pathway is granted, they or other producers may replicate the model for both crop cultivation and fuel production, massively expanding the amount of fuel produced under that pathway, or similar ones, and therefore the amount of area affected by related land use change. Satellite imagery may accurately show minimal land use impacts resulting from the activity used as the basis for certification *at the time of pathway certification*, however additional impacts may be much more apparent as production achieves larger scales; this could result in changes to the per-gallon or per-MJ estimates of LUC impact, especially when dealing with novel crops or approaches to cultivation. Putting such a heavy emphasis on satellite imagery exposes the program to significant risk that ILUC estimates for fuel+feedstock combinations not present in Table 6 would dramatically underestimate actual impacts.

Additionally, the proposed changes to language in § 95488.3 (d) could be interpreted as limiting the consideration of LUC effects to only those that can be assessed via satellite imagery. Doing so would create a risk that LUC impacts that could reliably be assessed via modeling, aerial or drone imagery, land use surveys, or other methods may be overlooked.

In total, the proposed changes to § 95488.3 (d) clarify many of the key terms referenced in this section and more clearly delineate the responsibilities and authority of the Executive Officer with regards to ILUC assessment. They do not substantively address concerns we, and other authors, have raised about the LCFS approach to ILUC in general, including the fact that the analysis underpinning Table 6 is outdated and assumes a supply shock far smaller than actual biofuel capacity growth in the U.S.[16] At the November 8th hearing, CARB Executive Board members instructed staff to hold an expert convening to review current science on ILUC, this is a critical first step in a critically important process to examine approaches to ILUC assessment and risk mitigation. Our work on the LCFS and related alternative fuel policies has repeatedly shown that ILUC can exert a significant impact on the CI scores of biofuels and must be adequately accounted for by policies like the LCFS to ensure that assessed GHG impacts align with actual ones and send appropriate associated incentive signals.[17]

Unrelated, and in addition to the above concerns, we note a shift from the use of the word "crop" to the word "biomass" in several places in § 95488.3 (d). This shift aligns with current understanding of biofuel land use impacts; land use change impacts are not solely limited to

[16] See our previous comment letters from August 27th, May 9th and February 20th.
[17] E.g. Brown, at al, (2021), Ro, Murphy, & Wang (2023). *Fuel Portfolio Scenario Modeling (FPSM) of 2030 and 2035 Low CarbonFuel Standard Targets in California*. https://doi.org/10.7922/G2S46Q8C
And Murphy & Ro (2024). *Updated Fuel Portfolio Scenario Modeling to Inform 2024 Low Carbon Fuel Standard Rulemaking*. https://doi.org/10.7922/G25719BV

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crop-based feedstocks, they can be observed in a variety of non-crop ones, too. As such, this change improves the ability of this section to accommodate the full range of biomass that might contribute to biofuel production in the future.

Modifications to § 94588.9 (f)

We note changes in § 95488.3 (f) that clarify the Executive Officer's responsibilities related to pathway renewal for biomethane pathways derived from anaerobic digestion of livestock manure. We reiterate a discussion from our October 16th comment letter that questions whether guaranteed renewals of biomethane pathway certification with full avoided methane credits are necessary to achieve state methane reduction goals, and discuss how such automatic recertification disagrees with principles of good LCA methodology.[18] We are finalizing a report that reviews current scientific literature on the topic of LCA methodology for assessing GHG impacts of anaerobic digestion (we have shared, under embargo, a preliminary copy with LCFS program staff for their review and will publish it as soon as possible). This review finds that current LCFS methodology specifies a counterfactual for the purposes of assessing avoided methane credits (open lagoons) that is uncommon among comparable studies. This paper identified 107 studies that reported GHG emission results from life cycle assessment of livestock AD at scales relevant to commercial application, 55 of which discussed counterfactual specification for assessing avoided methane credits in scenarios relevant to commercial application and with enough detail that we were able to ascertain the counterfactual being compared against. Of these 55 directly relevant studies, 9 used open lagoons as the counterfactual. An additional 21 specified other open storage (though likely lower-emitting) counterfactuals. The body of literature on commercial-scale operations in the U.S. was comparatively small, making it hard to ascertain how representative our sample is of projects that would seek LCFS pathways certification, but the diversity of counterfactual specifications under LCA study suggest the current counterfactual assumption in the LCFS may not align with typical practices in peer-reviewed scientific literature, and the extent to which it adequately characterizes the pool of likely LCFS applicants (to serve as a Tier 1 default) deserves exploration. The choice of open lagoons as a counterfactual may, in aggregate, yield CI scores that overestimate GHG benefits of such projects. Guaranteed recertification of pathways that adopt this counterfactual ensures that such overestimates would persist in the LCFS for multiple decades.

Modifications to § 94588.9 (g)

Proposed changes to this section establish a protocol for responding to changes in practices by a certification body that may mean it no longer meets the requirements for certification under the LCFS. Where a body no longer meets one specification in § 95488.9 (g) (8) (A), the proposed changes allow an opportunity for the certifying body to reestablish compliance. This appears to be intended to give certification systems the opportunity to return to compliance without disrupting their operations or the pathways that rely upon them. If non-compliance with one

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[18] Link: October 16 comment letter.

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specification in § 95488.9 (g) (8) (A) does not create a risk that fuels consumed in California would exceed their pathway CI scores, then allowing an opportunity to rectify the error and return to full compliance can help reduce compliance costs and administrative burden. Not all violations of the criteria specified in § 95488.9 (g) (8) (A) are innocuous, however. If the specific violation significantly impacts the assessment of the fuel in question's CI score, then allowing continued operation of the certification body may result in actual emissions that significantly exceed documented levels and appropriate LCFS credit revenue. In cases where companies continue to function despite no longer complying with one criterion in § 95488.9 (g) (8) (A), the Executive Officer may need the authority to determine whether CI scores from the entity appropriately reflect actual emissions from their respective fuels, and if not, appropriate corrective action must be taken to ensure that intentional non-compliance and use of the grace period offered under these proposed changes do not become a tactic to allow favorable, but inaccurate CI scores to generate credit.

Modifications of § 95491.2

The +/- 5% standard of accuracy specified in § 95491.2 (a) (1) (B) is conceptually clear and generally reasonable; however it may not be sufficient to ensure that published CI scores agree with actual GHG impacts. As long as measurement errors are ≤ 5% and independently distributed around the mean, then the aggregate impact of all errors is likely to be small. It must be clear, however, that errors are independently distributed. Where pathway applicants or certification bodies provide their own calibration procedures for measurement equipment, it is important that any errors be independently distributed around the value being measured. LCFS staff should also be aware that not every instrument can be evaluated in such a way as to yield a single accuracy metric, such as a +/- % score. In those cases, alternative assessments of accuracy may be needed. Additional clarity is also needed around how the +/- 5% accuracy standard referenced in § 95491.2 interacts with the 90th percentile standard provided in the definition of "Conservative."

Unclear or Confusing Variable Specification in § 95486.3 and § 95486.4

The 3rd 15 day package makes several changes to proposals relating to HRI and FCI crediting protocols. Several equations are presented to describe the calculation of station capacity, projected capacity, and credit generation for each pathway. While the description of each equation is clear, consideration of the full package of equations is made difficult due to a lack of clarity in variable definition.

Take for example the HD-FCI charging protocols (though the same basic problem is observed in both LD/MD and HD HRI and FCI pathways): § 95486.4 (b) (2) (F) provides the equation

$$Cap_{FCI}^{i} = F_{HD}^{site} \times P_{FCI}^{i} \times 24$$

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1605 Tilia Street, Suite 100, Davis, CA 95616
its.ucdavis.edu

and states "Cap^{i}_{FCI} is the FCI charging capacity (kWh/day) for the HD-FCI FSE i".

Later, § 95486.4 (b) (5) states "Cap_{HD-FCI} is the FCI charging capacity (kWh/day) for the HD-FCI FSE. This means that both Cap^{i}_{FCI} and Cap_{HD-FCI} are described as representing the same parameter (we can ignore the *i* superscript for this discussion since it implies a numbered example within a set and is relevant to the specific context of § 95486.4 (b) (2) (F)). Similarly, it is unclear whether the use of Cap_{HD-FCI} in § 95486.4 (b) (5) means that the capacity credits should use the nameplate capacity of the infrastructure as the basis for credit generation, or the adjusted capacity which takes into account the p^{i}_{FCI} utilization factor applied in § 95486.4 (b) (2) (F). Clarity on these issues is needed for stakeholders to fully understand how infrastructure capacity crediting, and the assessment of potential credits in relation to prior year deficits, will proceed.

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

From the start of this rulemaking process, 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, and the challenges this presents to California's long-term climate goals, this focus on corrective measures is understandable.

The limited scope, however, meant ignoring many critical and complex structural topics that, when fully explored, might offer avenues to improve the efficiency, resilience, and effectiveness of the LCFS or prevent future destabilizations of the LCFS credit market. As California has progressed through the early phases of its transition toward net-zero emissions, a number of parameters, protocols, or structural assumptions in the LCFS may no longer appropriately reflect current conditions. These include, but are not limited to EERs, ILUC adjustment values, the method by which fossil fuel displacement is credited, 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 fossil fuels rapidly exit California's fuel supply, expanding the LCFS to cover air, water, and rail fuels, integrating vehicle or transportation-system effects into fuel CI assessment, and differentiation between so-called "bridge" fuels and those with the capacity to achieve carbon neutrality. As discussed in our many comments throughout this rulemaking process, these issues have demonstrated actual or potential capacity to negatively affect the LCFS and/or continued 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.

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

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assets, excessive fuel price volatility, or erode policy certainty about California's climate policy portfolio. 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 challenges in 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.

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

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. 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,

Colin Murphy, Ph.D.
Co-Director, Low Carbon Fuel Policy Research Initiative
Associate Director, Energy Futures Program
Institute of Transportation Studies
University of California, Davis, California, USA