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Clerk of the Board
California Air Resources Board
P.O. Box 2815
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Submitted electronically via:
https://www.arb.ca.gov/lispub/comm/iframe_bcsubform.php?listname=lcfs2024

RE: POET COMMENTS ON DECEMBER 2023 PROPOSED LOW CARBON FUEL STANDARD AMENDMENTS

Dear CARB Board Members:

POET appreciates the opportunity to provide comments on the California Air Resources Board's ("CARB") December 2023 Proposed Low Carbon Fuel Standard ("LCFS") Amendments ("Proposed Amendments").

Since the LCFS program's inception, POET's biofuels have delivered continuous carbon reductions and public health benefits to the State of California. Through technological innovation, investments in carbon capture and renewable energy, and programs to reduce on-farm emissions, POET is steadily lowering the carbon intensity ("CI") of its fuel to meet the ambition of California's program as it grows and evolves. In several respects, however, CARB's proposed Low Carbon Fuel Standard Amendments adopt assumptions and establish requirements that will raise the cost and limit the future of low carbon liquid fuel in California. Specifically, by placing new and unnecessary burdens on the production of bioethanol, the proposal threatens to reduce the volume of bioethanol used in California's transportation fuel supply or impose new costs that would be passed on to California consumers. A reduction in bioethanol blending would result in higher greenhouse gas ("GHG"), particulate matter ("PM"), and other pollutant emissions from vehicles. As set forth below, we urge CARB to reconsider its proposal, and embrace the critical role that ever cleaner low-carbon liquid fuels must play to achieve the decarbonization of California's transportation sector.

We note that CARB has postponed its previously scheduled March 21, 2024, public hearing regarding its proposed LCFS amendments, in part, to facilitate "more consideration of the proposed sustainability guardrails."[1] We urge CARB to consider our comments as the agency reevaluates the current proposal regarding sustainability verifications for crop-based feedstocks.

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[1] *See* California Air Resources Board, *Low Carbon Fuel Standard, Low Carbon Fuel Standard Public Hearing Postponed*, https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard (last visited Feb. 16, 2024).

I. Overview

POET's vision is to create a world in sync with nature. As the world's largest producer of biofuel and a global leader in sustainable bioproducts, POET creates plant-based alternatives to fossil fuels that unleash the regenerative power of agriculture and cultivate opportunities for America's farm families. Founded in 1987 and headquartered in Sioux Falls, POET operates 34 bioprocessing facilities across eight states and employs more than 2,200 team members. With a suite of bioproducts that includes POET Distillers Grains, POET Distillers Corn Oil, POET Purified Alcohol, and POET Biogenic CO_2, POET nurtures an unceasing commitment to innovation and advances powerful, practical solutions to some of the world's most pressing challenges. Today, POET holds more than 80 patents worldwide and continues to break new ground in biotechnology, yielding ever-cleaner and more efficient renewable energy. POET is also a leading champion for nationwide access to E15, a renewable fuel blend made with 15% bioethanol.

POET supports CARB's dedication to decarbonizing the transportation sector and is committed to delivering low-carbon biofuels that will help California achieve its climate goals. The Proposed Amendments, however, fail to accurately recognize health and emissions benefits associated with bioethanol. In the comments below, POET argues that the proposed sustainability requirements should not apply to corn feedstocks. In the event CARB applies the sustainability requirements to corn, the LCFS should recognize emissions reductions associated with agricultural feedstock production and should not apply a land use change penalty to corn ethanol. POET also urges CARB to expedite its approval of E15 fuel in California and to reconsider several factual misconceptions regarding the costs, emissions reductions, and public health benefits associated with E15 adoption.

II. The California LCFS Must Recognize Bioethanol Climate and Health Benefits.

Bioethanol offers significant air quality and GHG emissions reduction benefits compared to petroleum-based gasoline. To achieve California's emissions reduction and air quality goals, CARB must ensure that bioethanol continues to play a central role in the LCFS program. The 2022 Scoping Plan acknowledges that liquid petroleum fuel will remain in California's transportation fuel mix for decades because legacy internal combustion vehicles will remain on the road for years.[2] CARB should incentivize the reduction of gasoline's CI in this legacy fleet, and we urge CARB to look to bioethanol to achieve these reductions.

Multiple studies show that blending bioethanol into the transportation fuel supply results in significantly lower lifecycle GHG emissions compared to petroleum-based gasoline. Specifically, studies show that emissions reductions attributable to bioethanol range from 41 to 46 percent compared to emissions associated with petroleum-based gasoline. According to the Department of Energy's Argonne National Laboratory ("ANL"), typical corn ethanol provides a 44 percent GHG reduction compared to gasoline.[3] Similarly, researchers affiliated with Harvard University, MIT, and Tufts University conducted a meta-analysis showing that corn ethanol as of 2021 offers an

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[2] California Air Resources Board, *2022 Scoping Plan for Achieving Carbon Neutrality*, at 190 https://ww2.arb.ca.gov/sites/default/files/2022-12/2022-sp_1.pdf (Nov. 16, 2022).
[3] Lee, Uisung et al., *Retrospective Analysis of the U.S. Corn Ethanol Industry for 2005–2019: Implications for GHG Emission Reductions*, Biofpr Vol. 15 Issue 5, at 1328 (May 4, 2021) https://doi.org/10.1002/bbb.2225.

average GHG reduction of 46 percent compared to gasoline ("Scully study").[4] For comparison, the average CI of pure gasoline is approximately 96 gCO2e/MJ.[5]

According to the USDA, from 2011 to 2019, the average CI of ethanol fuel has decreased by approximately 25 percent.[6] This decrease can be attributed to (a) market-driven changes in corn production that lowered the intensity of fertilizer and fossil fuel use on farms; (b) more efficient use of natural gas and electricity at ethanol production facilities; and (c) improvements in land use change analyses based on hybrid economic-biophysical models that account for land conversion, land productivity, and land intensification.[7] In other words, older assessments using inexact data overestimated bioethanol's CI, and bioethanol has improved in environmental performance over time. As a result, more recent studies demonsrate that bioethanol provides much more significant emissions reductions that previously understood.[8]

Under CARB's own CA-GREET model, bioethanol provides significant GHG benefits. CA-GREET has found that bioethanol used in the state in 2022 reduced emissions by 40 percent, on average, compared to gasoline.[9] From 2011 to 2020, CARB data show that the use of bioethanol cut GHG emissions from the California transportation sector by 27 million MT CO_2e, more than any other fuel used to meet the state's LCFS requirements.[10]

POET plants selling bioethanol into California provide significant emissions reduction benefits compared to gasoline. Multiple POET facilities have current certified CIs in the mid-60s,[11] and POET supplies corn kernel fiber ethanol to California with certified CIs in the 20s.[12]

In addition to GHG benefits, a recent analysis from leading national experts found air quality and public health benefits associated with higher biofuel blends in gasoline, including reductions in

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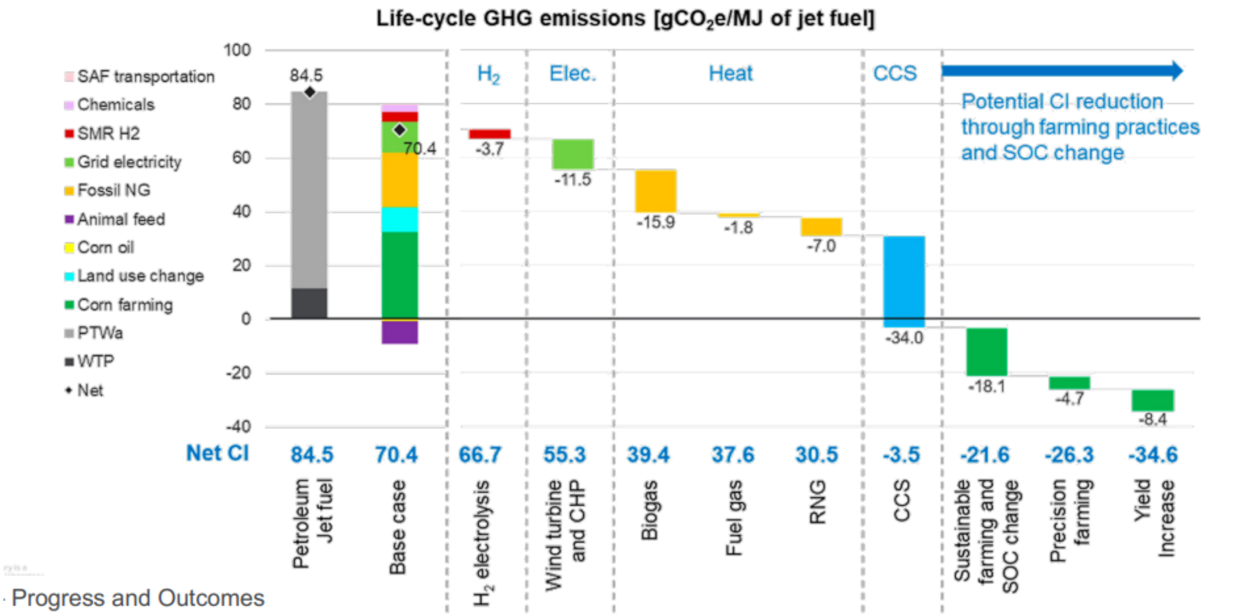
[4] Scully, Melissa et al., *Carbon Intensity of Corn Ethanol in the United States: State of the Science*, ENVIRONMENTAL RESEARCH LETTERS, at 16 (March 10, 2021) https://iopscience.iop.org/article/10.1088/1748-9326/abde08; *see* Appendix B, Environmental Health & Engineering, *Comments on 2024 Proposed Low Carbon Fuel Standard Amendments*, at 10 (Feb. 20, 2024) [hereinafter "Appendix B"].
[5] *Id*.
[6] U.S. Dep't of Agriculture, *The California Low Carbon Fuel Standard: Incentivizing GHG Mitigation in the Ethanol Industry*, at 1 (Nov. 2020) https://www.usda.gov/sites/default/files/documents/CA_LCFS_Incentivizing_Ethanol_Industry_GHG_Mitigation.pdf.
[7] *Supra* note 5, at 2.
[8] A 2022 study by Lark, et al., estimates a higher LUC value for corn starch bioethanol. This higher estimate is an outlier, and rebuttals were published by Environmental Health & Engineering, https://www.pnas.org/doi/10.1073/pnas.2213961119, and the U.S. Department of Energy, https://greet.es.anl.gov/publication-comment_environ_outcomes_us_rfs. *See* Lark, Tyler et al., *Environmental Outcomes of the US Renewable Fuel Standard*, PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (PNAS) (2022), https://doi.org/10.1073/pnas.2101084119.
[9] California Air Resources Board, *LCFS Data Dashboard*, Figure 5a (last visited Feb. 17, 2024) https://ww2.arb.ca.gov/resources/documents/lcfs-data-dashboard.
[10] California Air Resources Board, *Low Carbon Fuel Standard Reporting Tool Quarterly Summaries, Quarterly Data Summary and Spreadsheet* (last visited Feb. 17, 2024) https://ww2.arb.ca.gov/resources/documents/low-carbon-fuel-standard-reporting-tool-quarterly-summaries.
[11] California Air Resources Board, *Current Pathways*, *e.g*. Jewel, Hanlontown. Ashton, Mitchel (last updated Feb. 9, 2024) https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/fuelpathways/current-pathways_all.xlsx.
[12] *Id., e.g*. Ashton, Mitchell, Gowrie, Leipsic, Preston, Alexandria, Fostoria.

particulate matter ("PM"), carbon monoxide ("CO"), and total hydrocarbons ("THC").[13] This study was the first large-scale analysis of data from light-duty vehicle emissions that examines real-world impacts of bioethanol-blended fuels on regulated air pollutant emissions. The study found that CO and THC emissions were significantly lower for higher bioethanol fuels for port fuel injected engines under cold-start conditions. The study found no statistically significant relationship between higher bioethanol blends and nitrogen oxides ("NOx") emissions. With regard to PM, studies show that emissions decrease by 15 – 18% on average for each 10% increase in ethanol content under cold-start conditions.[14] A 2022 University of California Riverside ("UC") study funded in part by CARB assessing the impact of E15 on air pollutant emissions for model year vehicles 2016 to 2021 was consistent with these results, finding that replacing E10 with E15 reduced PM emissions by 18%, with cold-start emissions being reduced by 17%.[15] Analyses by professors at Tufts University show that the associated health benefits may be most significant in disadvantaged communities in areas of high traffic density and congestion.[16] CARB recently published a Multimedia Evaluation of E11- E15 Tier 1 Report with conclusions consistent with these studies.[17]

Bioethanol's current CI is a ceiling — not a floor. As the Scully study notes, "[m]arket conditions that favor greater adoption of precision agriculture systems, retention of soil organic carbon, and demand for co-products from ethanol production may lower the CI of corn ethanol further."[18] And under the federal Inflation Reduction Act, biofuel producers like POET are incentivized to make investments in carbon-reducing technologies, including carbon dioxide capture and utilization strategies, and investments in low-carbon process energy that have the potential to drastically lower the CI of every gallon of ethanol we produce. As the ANL chart below shows, through investment and innovation, bioethanol has the ability to become a zero-carbon fuel.[19]

[13] *See* Kazemiparkouhi, Fatemeh et al., *Comprehensive US Database and Model for Ethanol Blend Effects on Regulated Tailpipe Emissions*, SCIENCE OF THE TOTAL ENVIRONMENT, at 15 (March 2022), https://www.sciencedirect.com/science/article/pii/S0048969721065049?via%3Dihub; *see* Appendix B at 4-5.
[14] *Comprehensive US Database and Model for Ethanol Blend Effects on Regulated Tailpipe Emissions* at 5, 11, 13; *see* Appendix B at 4-5.
[15] Karavalakis, Georgios et al., *2022 Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15. Final Report*, prepared for Riverside, California Air Resources Board, Growth Energy Inc./Renewable Fuels Association, and USCAR., at 22-23, 36 (June 2022), https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Final_Report_7-14-22_0.pdf; *see* Appendix B at -5.
[16] *See* Appendix C, Tufts University Department of Civil and Environmental Engineering, *Air Quality and Public Health Comments to RFS* (Feb. 3, 2022); *see* Appendix B at 8-9.
[17] *See* Renewable Fuels Association and Growth Energy, *Multimedia Evaluation of E11-E15 Tier 1 Report* (June 4, 2020), https://ww2.arb.ca.gov/sites/default/files/2022-07/E15_Tier_I_Report_June_2020.pdf.
[18] *Supra* note 5, at 2.
[19] Argonne National Laboratory, *DOE Bioenerty Technology Office (BETO) 2023 Project Peer Review, Life Cycle Analysis of Biofuels and Bioproducts and GREET Development*, at 18 (April 4, 2023), https://www.energy.gov/sites/default/files/2023-05/beto-16-project-peer-review-dma-apr-2023-wang.pdf.



CARB recognized bioethanol's role in the LCFS program's success in the Initial Statement of Reasons for these proposed amendments and during the December 7, 2021, Public Workshop on Potential Future Changes to the LCFS program.[20] As CARB noted, bioethanol has effectively displaced fossil fuels to reduce GHG emissions. In 2020, bioethanol was the largest source of LCFS compliance by volume and the second-largest source by number of credits. Because of the GHG and air quality emissions reductions associated with bioethanol, incentives to increase bioethanol blending into California fuel advance California's decarbonization and air quality goals. As bioethanol producers continue to reduce lifecycle emissions, bioethanol will continue to drive the emissions reductions California needs to decarbonize and improve air quality.

III. CARB Should Expedite E15 Adoption Rather Than Restrict Ethanol Imports into California as Proposed.

In its rulemaking materials, CARB assumes that "E10 will continue to be used in California through 2046."[21] This assumption inconsistent with the near universal adoption of E15 throughout the United States. California the only state in the Union yet to approve E15 as part of its transportation fuel supply, and its reluctance to do so is in tension with the State's climate goals. Even under the most aggressive targets for electric vehicle adoption, there will be millions of internal combustion engines on the road for decades to come. Authorizing the use of E15, which is EPA-approved for 96% of light duty vehicles, will help decarbonize these legacy vehicles and, according to California's own studies, deliver improved public health outcomes in areas most affected by tailpipe emissions.

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[20] *See* California Air Resources Board, *Staff Report: Initial Statement of Reasons* [hereinafter "ISOR"], at 18 (Dec. 19, 2023), https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/isor.pdf; California Air Resources Board, *Low Carbon Fuel Standard Public Workshop: Potential Future Changes to the LCFS Program*, at 6 (Dec. 7 2021), https://ww2.arb.ca.gov/sites/default/files/2021-12/LCFS%2012_7%20Workshop%20Presentation.pdf.

[21] *See* California Air Resources Board, *Proposed Low Carbon Fuel Standard Amendments, ISOR*, Appendix C-3, at 1 (Dec. 19, 2023), https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/appc-3.pdf.

A. E15 offers significant climate and public health benefits.

The skepticism CARB expresses towards E15 adoption in the ISOR appears to arise from a series of factual misconceptions. First, CARB notes that E15 adoption requires a Multimedia Evaluation ("MME") and approval by the Environmental Policy Council ("EPC"), and states that the process "takes years to complete."[22] But the E15 MME process in California has been underway for over four years, with revisions to a Tier III Report now under review by the Multimedia Working Group ("MMWG"). UCR's research conducted in connection with the MME process demonstrates public health benefits in association with the adoption of E15, concluding that E15 reduces CO, $PM_{2.5}$, VOCs, and GHGs with no increase in NO_x.[23] As discussed above, another study conducted by Environmental Health & Engineering, Inc., a multi-disciplinary team of environmental health scientists and engineers affiliated with Harvard and Tufts Universities, found that corn-based bioethanol has a 46% lower lifecycle CI on average than gasoline.[24] This finding confirms recent studies conducted by the Department of Energy and Department of Agriculture showing that bioethanol reduces lifecycle emissions by 43-52%.[25] A study by Air Improvement Resource, Inc. also showed that shifting from E10 to E15 in California would cut 1.8 million metric tons of GHG emissions annually, equivalent to removing more than 411,000 cars off the road.[26] In short, there is no basis for the MMWG or the EPC to conclude that "allowing E15 use in California would have significant adverse impacts on public health or the environment."[27] To the contrary, MMWG, EPC and CARB have every reason to conclude that E15 adoption will promote Calfornia's climate goals and alleviate air pollution. Indeed, E15 is likely to assist California in complying with EPA's recently stregthened National Ambient Air Quality Standards for Particlulate Matter.[28]

B. Assumed barriers to E15 adoption identified in the ISOR are easily surmountable.

CARB expresses concern that "even if E15 is approved in California, there are still several market barriers that would limit its adoption and availability in the state including vehicle compatibility, fuel infrastructure readiness, and consumer acceptance."[29] Each of these assumed barriers is either overstated or proceeds from factual misconceptions.

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[22] *Id.*
[23] *Supra* note 14, at 54.
[24] *Supra* note 5, at 16; *see* Appendix B at 10.
[25] *Supra* note 4, at 1328; ICF, *A Life-Cycle Analysis of the GHG Emissions of Corn-Based Ethanol* (prepared for U.S. Department of Agriculture), at 99 (Sept. 5, 2018) https://www.usda.gov/sites/default/files/documents/LCA_of_Corn_Ethanol_2018_Report.pdf.
[26] Air Improvement Resource, Inc., *GHG Benefits of 15% Ethanol (E15) Use in the United States*, at 4 (Nov. 30, 2020) http://www.airimprovement.com/reports/national-e15-analysis-final.pdf.
[27] ISOR, Appendix C-3 at 1.
[28] *See* EPA, *Reconsideration of the National Ambient Air Quality Standards for Particulate Matter* (Feb. 5, 2024) (to be codified at 40 CFR Parts 50, 53, and 58), https://www.epa.gov/system/files/documents/2024-02/pm-naaqs-final-frn-pre-publication.pdf; EPA, *EPA Finalizes Stronger Standards ror Harmful Soot Pollution, Significantly Increasing Health And Clean Air Protections for Families, Workers, and Communities* (Feb 7, 2024), https://www.epa.gov/newsreleases/epa-finalizes-stronger-standards-harmful-soot-pollution-significantly-increasing (According to EPA, of the 52 counties projected to be out of attainment with the new standards, 23 are in California.).
[29] *See* ISOR, Appendix C-3 at 1.

First, CARB presents as an obstacle to E15 adoption the fact that EPA has approved E15 for "only vehicles model year 2001 and newer."[30] But that vehicle cohort constitutes the overwhelming majority of cars and trucks on the road in Califoirnia. CARB next notes that "some automakers have warned that using E15 may void vehicle warranties or cause damage to engines and fuel systems."[31] But almost every automaker warranties for E15 in their new vehicles now, and Honda, Toyota, Volkswagen, GM, Ford, Hyundai, and Tata have done so since at least 2014.[32] CARB also states that "the existing fuel infrastructure in California is not universally compatible with E15, as some tanks, pipes, pumps, and dispensers may need to be upgraded or replaced to handle higher ethanol blends." But most retail fueling infrastructure is ready for E15 today. According to numerous reports by the National Renewable Energy Laboratory, U.S. Department of Energy, EPA, Steel Tank Institute, and Fiberglass Tank and Pipe Institute,[33] most underground storage tanks made in the last 30 years are approved up to 100% bioethanol, and most fuel dispensing equipment is already manufacturer-approved for E15. In fact, since the 1980s, petroleum equipment manufacturers have offered compatible products for blends above 10% bioethanol, including storage tanks, piping, valves, hanging hardware, dispensers, hoses, and nozzles, as standard equipment.[34] Furthermore, any concerns regarding midstream infrastructure are also misplaced: 5% less gasoline flowing through California's existing pipelines, storage tanks, and terminals can be reallocated to accommodate 5% more ethanol in order blend E15. And contrary to CARB's stated concerns, there is evidence throughout the United States that consumers will choose E15 where it is offered. Among retailers that offer E15, the fuel has developed a strong sales record, generating 30 to 56% of total fuel sales in many locations.[35]

In short, there is no reason for CARB to delay the E15 approval process in California, which will result in climate and public health benefits consistent with the agency's policy goals.

IV. CARB's Proposed Sustainability Requirements Should Not Apply to Corn as a Biofuel Feedstock.

CARB's Proposed Amendments would impose "sustainability requirements" on crop-based and forest-based feedstocks. Although it does not delineate any prescribed standards, the proposal

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[30] *Id.*
[31] *Id.* at 2.
[32] *See* Renewable Fuels Association, *E15 Warranty Data Compiled*, https://d35t1syewk4d42.cloudfront.net/file/2648/MY2024%20E15%20Chart_RFA%20vEngines.pdf.
[33] *See e.g.*,U.S. Department of Energy, *Handbook for Handling, Storing and Dispensing E85 and Other Ethanol-Gasoline Blends*, at 11 (Feb, 2016), https://afdc.energy.gov/files/u/publication/ethanol_handbook.pdf; *see* EPA, *Report on UST System Compatibility with Biofuels*, at 5 (July 2020), https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.epa.gov%2Fsites%2Fdefault%2Ffiles%2F2020-07%2Fust_compatibility_booklet_formatted_final_7-13-2020.docx%23%3A~%3Atext%3DMost%2520currently%2520installed%2520UST%2520systems%2Chigher%2520blends%2520are%2520now%2520available.&wdOrigin=BROWSELINK; Steel Tank Institute, *Steel Tanks: Compatible with All Biofuel Blends*, (last visited Feb. 17, 2024), https://stispfa.org/resource/steel-tanks-compatible-with-all-biofuel-blends/.
[34] *See* PEI, *Petroleum Equipment Institute Compliance Letters by Manufacturer*, (last visited Feb. 17, 2024), https://stispfa.org/resource/steel-tanks-compatible-with-all-biofuel-blends/.
[35] Growth Energy, *The E15 Advantage: The Secrets to Success*, at 1 (Feb. 2021), https://e15advantage.com/wp-content/uploads/2021/02/GE-E15-Advantage-White-Paper.pdf.

mandates that crop-based and forestry-based feedstocks "[m]aintain continuous third-party sustainability certification under an Executive Officer approved certification system."[36]

Under the proposal, if feedstock crops are not certified as required, the resulting biofuels are subject to harsh penalties: a noncompliant bioethanol fuel would receive a CI value equivalent to ultra-low sulfur diesel of 105.76 g/MJ.[37] Uncertified ethanol would lose its status as a significant credit generator under the current program and be treated instead as a deficit generator under the new regime. Indeed, uncertified ethanol would be regarded as having a higher CI than gasoline, which would mean that obligated parties would have to purchase credits to cover the deficit generated by ethanol blended into fuels. This would create a significant disincentive to the continued blending of ethanol into California fuel. The result would be either less blending and higher GHG emissions and air pollution, or higher prices that would ultimately be passed on to California consumers.

As explained further below, CARB's proposal would cause adverse environmental consequences if the sustainability requirements as proposed are applied to corn. We urge CARB to reevaluate this proposal and exclude corn from any "sustainability requirements" to be imposed on crop-based feedstocks.

A. CARB's "sustainability requirements" as applied to corn threaten to increase GHG, toxic, and criteria pollutants in California.

CARB's proposed "sustainability requirements" would impose significant costs on the ethanol supply chain. These costs would disincentivize ethanol use in the fuel supply or be passed along to consumers. Decreased ethanol use would increase GHG, PM, and other emissions associated with transportation in California.

1. The cost of the sustainability certifications would impose significant costs on biofuels producers, which would be passed through the supply chain.

Although CARB has not yet specified the sustainability programs which may qualify for certification under the LCFS, aspects of the proposed regulations point strongly to certain existing certification systems as likely candidates for CARB approval. Of particular note, the proposed regulation requires that a certification system be recognized by an international, national, or state/provincial government for at least 24 months, among other requirements.[38] POET is concerned that the only certification systems that will be able to satisfy these requirements are those designed to meet the EU RED II standards, such as ISCC. To the extent that assumption is mistaken, POET seeks clarification regarding the types of sustainability schemes that CARB believes may satisfy the proposed regulations.

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[36] California Air Resources Board, *Appendix A-1 Proposed Regulation Order: Proposed Amendments to the Low Carbon Fuel Standard Regulation* [hereinafter "Proposed Reg."], at Section 95488.9(g)(1) (Dec. 19, 2023), https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/lcfs_appa1.pdf.

[37] *Id.* at § 95488.9(g)(1)(A). It is notable that all crop-based fuels are assigned the diesel default CI if they do not obtain sustainability certification, rather than the diesel CI for diesel substitutes and the gasoline CI for gasoline substitutes.

[38] *Id*. at § 95488.9(g)(1)(B)(1).

Because of the likely significance of RED II and ISCC certifications in the proposed CARB framework, we summarize some of the relevant aspects of each in Appendix A. In that Appendix, we explain that ISCC Plus is the ISCC certification framework that would most likely apply to the American biofuel supply chain because ISCC Plus is designed for non-EU markets.

POET certifies some of its biofuels for export under both ISCC Plus and the closely related ISCC EU standard. Compliance with these standards comes with significant costs in the form of premiums paid to farmers to shoulder the burden of regulatory scrutiny. California currently utilizes approximately 1.4 billion gallons of ethanol per year,[39] which translates to approximately 500 million bushels of corn.[40] A premium cost of even a few cents per bushel would add up to millions per year in certification-related costs for just the corn that is shipped to the California market, not to mention the broader pool of corn that would have to comply in order to maintain the option of derivative ethanol being shipped to California without a penalty. Costs of this magnitude could translate to an increase of several cents per gallon in gasoline prices when passed down to the consumer.

2. Significant logistical hurdles present substantial challenges to certification of the corn supply used to make ethanol shipped to California by 2028.

Forty percent of the corn grown in the United States is used for ethanol production.[41] California is by far the largest ethanol market in the country. As a result, CARB's proposed certification scheme will require huge swaths of American farmland to come into compliance with the certification requirements in just a few years.

As described in greater detail in Appendix A, the logistical challenge is magnified because the frameworks like ISCC require the entire corn ethanol supply chain to obtain certification in order to comply with ISCC Plus. The supply chain to California involves thousands of parties, including farmers, corn aggregators, biofuel processors, traders and marketers. It is likely that such certification will be the largest task that the ISCC system has ever undertaken. It is not clear that there are even a sufficient number of certification bodies (the entities that do the work to obtain ISCC certification) to certify the entire corn supply chain in America, let alone the supply chains for the other crop-based fuels to which CARB's proposed sustainability requirements would apply. Thus, there is significant risk that not all ethanol that could potentially ship to California will be made from certified crops in 2028. This means that a substantial volume of ethanol may be penalized and treated as a deficit-generating fuel whether or not the feedstock used to produce the fuel could actually satisfy sustainability criteria.

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[39] Renewable Fuels Association, *California* (May 2023), https://d35t1syewk4d42.cloudfront.net/file/2619/2023%20Infographic_CA.pdf.

[40] Irwin, Scott, *2019 Ethanol Production Profits: Just How Bad Was It?*, Department of Agricultural and Consumer Economics University of Illinois (Jan. 29, 2020) (finding that there are approximately 2.8 gallons of ethanol per bushel of corn), https://farmdocdaily.illinois.edu/2020/01/2019-ethanol-production-profits-just-how-bad-was-it.html.

[41] USDA, *Global Demand for Fuel Ethanol Through 2030*, at 6 (Feb. 2023), https://www.ers.usda.gov/webdocs/outlooks/105762/bio-05.pdf?v=5239.1.

3. The increased costs associated with corn ethanol would lead to either decreased ethanol blending or higher prices for consumers.

As described above, ethanol derived from uncertified feedstocks would face a significant CI penalty, creating a CI surcharge associated with continued blending of ethanol into the California fuel supply. On the other hand, ethanol that meets certification requirements would face significant costs associated with enrolling farmers in certification programs. Either way, the certification requirements will significantly increase the price of ethanol compared to current levels.

Fuel blenders will be faced with limited options: use less ethanol in fuel, pass the additional costs on to consumers, or both.

4. Less ethanol blending would result in increased PM and other emissions from cars.

As discussed above and in the attached report by EH&E, lower levels of ethanol blending would like result in increased levels of PM and other pollutants. This has been confirmed by UCR in a study funded by CARB. As a result, the proposal threatens to increase the emission of both criteria and toxic air pollutants in California.

5. A rule that increases PM and other emissions would be inconsistent with AB 32.

AB 32,[42] the authorizing legislation for the Low Carbon Fuel Standard Program, directs CARB to adopt market-based measures to achieve the GHG reduction goals of the law.[43] However, AB 32 also placed important limits on such measures. Specifically, the legislature was acutely concerned with the impacts of GHG reduction measures on the levels of other significant pollutants. As such, it provided that market-based GHG reduction measures must be designed "to prevent any increase in the emissions of toxic air contaminants or criteria air pollutants."[44]

As discussed above, ethanol reduces a number of pollutants, including PM. However, CARB's proposal may result in CI penalties for a significant volume of importedethanol, disincentivizing ethanol use in California fuels. Pursuant to the attached EH&E analysis, a reduction in ethanol blending would raise criteria and toxic pollutant emissions in California in a manner inconsistent with AB 32. CARB should avoid adopting a rule that would increase both GHG emissions and other pollutants in California.

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[42] California Global Warming Solutions Act, Cal. Health & Safety Code § 38500-38599.
[43] Cal. Health & Safety Code § 38570.
[44] *Id.* § 38570(b)(2).

B. CARB Should Focus Any Sustainability Requirements on the Feedstocks That Present the Most Concern.

1. Starch feedstocks do not present the same land use change concerns as oils.

As discussed in greater detail by EH&E in Appendix B, starch-based biofuels generally present significantly lower land-use change concerns than oil-based fuels.[45] Prior assessments have determined that oil feedstocks may have land use change impacts several times that of starch feedstocks, with some types of oils have order of magnitude greater impacts than corn starch.[46] This makes sense given the relatively direct connection between palm oil and land use change versus the more tenuous and indirect assertions regarding the impact of corn as a feedstock.

2. CARB's prior workshops and presentations focus on non-starch feedstocks.

Consistent with the heightened concerns presented by non-starch feedstocks in the EH&E paper, recent CARB workshops and presentations do not focus on corn starch as the feedstock of most concern with respect to sustainability. For example, the Stanford presentation at the May 31, 2023, CARB workshop only focused on concerns with crop oils and presented a crop oil cap as the proposed policy mechanism.[47] The workshop materials did not discuss or address concerns with corn starch feedstocks.

Similarly, in a January 11, 2024, presentation at the OPIS Conference, CARB presented on concerns with crop-based biofuels. The presentation, however, only highlighted data indicating the sharp increase in oil feedstocks utilized for biofuel production.[48] The slides do not present any data related to starch.

In fact, the administrative record does not appear to highlight information that supports the contention the corn starch is a feedstock that presents such significant concern that new sustainability certification requirements are warranted, especially when ILUC is already accounted for under the existing LCFS framework.

3. Other jurisdictions such as the EU recognize that sustainability concerns associated with non-starch feedstocks are significantly higher than concerns with ethanol.

To the extent CARB is more focused on land-use change concerns associated with oils, it is not alone. As discussed in greater detail in Appendix A, the EU, for example, has found much more significant land use change concerns associated with oils than starch. While the EU does not assign ILUC penalties to CI scores because of the inherent uncertainty associated with ILUC, it estimates that corn-based feedstocks have an ILUC impact of 12 g/MJ, while it assigns an estimate of 55 g/MJ (almost five times higher) to oil feedstocks. Even with the land-use change figure estimated

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[45] *See* Appendix B at 10-12.
[46] Appendix B at 11.
[47] California Air Resources Board, *Low Carbon Fuel Standard Virtual Community Meetings, Stanford Presentation*, at 6 (May 31, 2023), https://ww2.arb.ca.gov/sites/default/files/2023-05/Stanford%20Presentation.pdf.
[48] *See* Appendix D.

by Europe or California, ethanol still presents a significant GHG benefit compared to petroleum fuels, while the 55 g/MJ figure significantly erodes the benefits of oil-based fuels.[49]

C. Any ILUC risks associated with ethanol are already accounted for in CA-GREET.

Whatever ILUC concerns CARB may have with respect to starch, the issue is already addressed by the ILUC penalty of 19.8 g/MJ incorporated in California's GREET model. This contrasts directly with the European and Canadian systems where no ILUC penalty is assessed. In Europe and Canada, feedstock sustainability requirements serve the purpose of addressing land use change concerns in the absence of an ILUC penalty.[50] In California, where the CI framework already addresses ILUC, there is no need for a second set of requirements designed to address the same issue.

D. Penalizing uncertified corn ethanol would impair the LCFS's ability to achieve its GHG reduction goals.

As discussed above, all ethanol derived from uncertified feedstocks would receive a penalty and be assigned a CI of 105.76 g/MJ no matter how advanced and energy efficient the ethanol plant, and no matter how low the fuel's actual CI as calculated through CA-GREET.

Assigning a high default CI value to ethanol regardless of the CI of its production process cuts against the purpose of the LCFS program, which is to incentivize lower carbon behaviors. Treating all uncertified ethanol identically (and worse than gasoline) would remove the incentive to innovate and pursue carbon reducing manufacturing practices. Uncertified plants would have no incentives from the LCFS to engage in behaviors that would lower emissions.

Further, the contemplated CI penalties could chase low-CI ethanol out of the California market. The modeling performed by CARB around the feasibility of the LCFS program for decades to come assumes that relatively low CI corn ethanol will continue to be available in California in the form of E10. If some volume of the ethanol flowing into California is uncertified, those assumptions may fail because E10 will become a higher CI fuel that generates increased carbon emissions under the LCFS system. Further, any decrease in ethanol blending would tighten the availability of carbon credits and impact CARB's projections of the marketplace.

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[49] Note that corn oil derived as a co-product of ethanol production would not be assessed a similar penalty. Much of the CI burden is attributed to the ethanol rather than such corn oil.

[50] Notably, the model used to determine the CI of fuel under Canada's Clean Fuel Regulations ("CFR") does not assess an ILUC penalty, and the sustainability requirements applied to American bioethanol under the CFR is satisfied by "legislative recognition" that acknowledges safeguards imposed by the United States' federal environmental laws. Clean Fuel Regulations, SOR/2022-140 §§ 53(1), 55(1); *see* Canada's Fuel Lifecycle Assessment Model available at https://www.canada.ca/en/environment-climate-change/services/managing-pollution/fuel-life-cycle-assessment-model.html.

V. CARB Has Not Clearly Articulated a Standard for Sustainability, and Delegates Standard Setting to Third Parties.

CARB's proposed sustainability requirements do not articulate a substantive standard, and do not define the concept of "sustainability." Instead, the proposed regulation describes in broad strokes the type of certification system that can be used to demonstrate "sustainability" and then requires adherence to rules generated and applied by third-party auditors. This approach is problematic.

As discussed above, the proposed regulation seems to suggest that the ISCC certification system could be used to meet CARB's proposed sustainability requirements. But that certification framework is designed to meet the substantive standards for sustainability established by RED II in the EU.[51] If CARB were to approve the ISCC certification program, they would, in effect, be adopting the EU's substantive sustainability criteria into California law, without the opportunity to modify those requirements and without opportunity for notice and comment by the public.

There are legal obstacles here. California law prohibits the delegation of certain governmental functions to non-governmental third parties.[52] The nondelegation doctrine "requires the legislature or a regulatory agency to exercise the final say over whether any particular regulation becomes law."[53] Delegation is especially discouraged when it involves control over fundamental policy decisions and when inadequate safeguards are present that would allow the California government to control the delegation of authority and prevent its misuse.[54]

By leaving the determination of sustainability standards to the ISCC, CARB would be delegating a fundamental policy decision to third parties. The EU went to great lengths to engage with the public and negotiate among its members to establish legislation defining sustainability in a manner that is palatable to that government and those member states. CARB would be abdicating its role in that important process, and assigning the task to third parties, perhaps to even the EU if it approves EU-based certification systems.

Although CARB does retain the ability to approve or disprove certification systems, since CARB does not define "sustainability," it does not retain the ability to control the most central element of the certification schemes. In other words, the ISCC or other sustainability certification programs must necessarily rely on a definition of "sustainability" established by an authority other than CARB. As a result, CARB cannot control the ultimate policy outcomes that could result from such a definition.

Finally, under the proposed framework the public will have no notice or opportunity to comment on the substantive sustainability principles that CARB will adopt by approving a certification scheme. If it chooses to approve a system like ISCC, CARB will be adopting an entire legislative and regulatory system developed and approved entirely by foreign entities, without opportunity

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[51] *See* Appendix A.
[52] *Monsanto Co. v. Office of Environmental Health Hazard Assessment*, 22 Cal. App. 5th 534, 556 (5th Dist. 2018) (citing *International Assn. of Plumbing etc. Officials*, 55 Cal.App.4th 251, 254 (3rd Dist. 1997) (holding that legislation violated the nondelegation doctrine when it delegated regulatory determinations to individuals)).
[53] *Light v. State Water Resources Control Bd*., 226 Cal. App. 4th 1463, 1491 (5th Dist. 2014).
[54] *See Golightly v. Molina*, 229 Cal. App. 4th 1501, 6 (2nd Dist. 2014); M*onsanto Co. v. Office of Environmental Health Hazard Assessment*, 22 Cal. App. 5th 534, 555 (5th Dist. 2018).

for engagement by California stakeholders. This procedure presents significant problems under the California Administrative Procedure Act and other laws.

VI. CARB's Environmental Analysis Does not Adequately Assess the GHG and Air Pollutant Impacts of its Sustainability Proposal.

CEQA requires that an agency's environmental analysis contain "[a] discussion and consideration of environmental impacts, adverse or beneficial, and feasible mitigation measures which could minimize significant adverse impacts identified," as well as "[a] discussion of cumulative and growth-inducing impacts."[55] CEQA requires CARB to discuss "inconsistencies between the proposed project and applicable general plans, specific plans and regional plans," which includes the State Implementation Plan ("SIPs") and plans for the reduction of GHG emissions.[56]

As discussed above, either penalizing uncertified ethanol or imposing significant certification costs on the ethanol supply chain would create incentives to reduce ethanol blending in California through a straightforward causal connection: increasing the cost of a fuel component threatens to decrease use of that component.

Despite this implication of the Proposed Amendments, the Draft Environmental Impact Analysis[57] fails to analyze the possibility of and impacts resulting from lower ethanol blends in California. Again as already discussed, lower ethanol blending would result in higher emissions of PM and several other pollutants. Failure to consider and analyze these impacts is a failure to prepare an adequate environmental analysis under CEQA.

In addition to a general analysis of adverse environmental impacts, CEQA requires CARB to discuss inconsistencies between the Proposed Rule and any SIPs or other state plans regarding PM. This discussion is especially important given EPA's recent decision to tighten the PM NAAQS, which impacts counties across California.[58] According to the EPA figures below, the tightened standards will cause most of California to be in non-attainment for PM for years to come. CARB is therefore not analyzing the potential impacts of its own rule on one of the few fuel additives that can reduce PM emissions in the existing fleet, and without which California would struggle to meet PM standards.[59]

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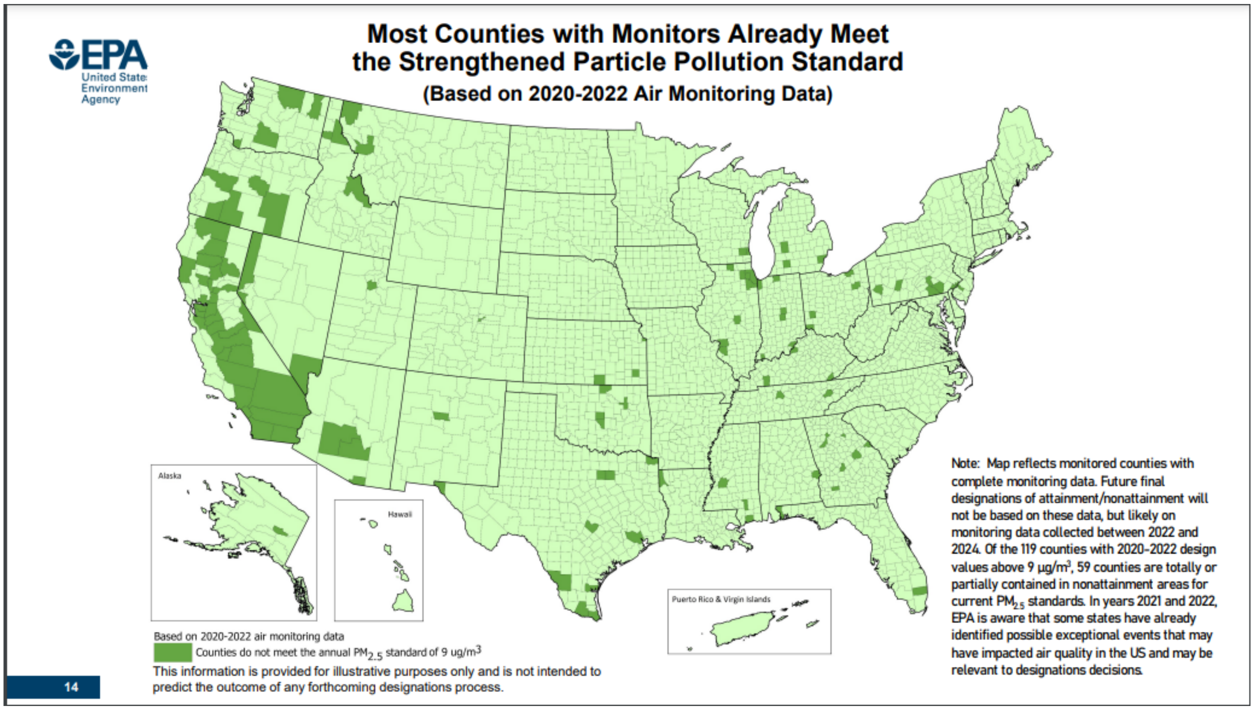
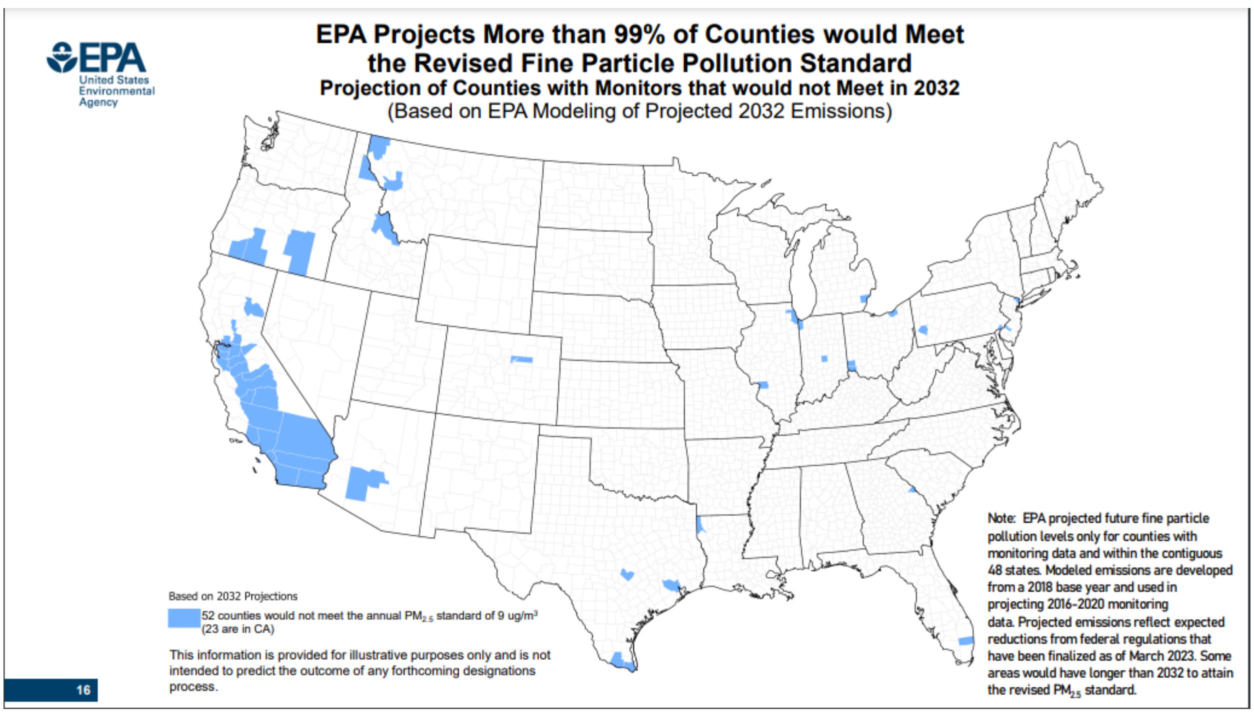
[55] 17 CCR § 60004.2(a).
[56] 14 CCR § 15125(d).
[57] *See Appendix D: Draft Environmental Impact Analysis for the Proposed Low Carbon Fuel Standard Regulation* (Jan. 2, 2024), https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/appd.pdf.
[58] *See* EPA, *Reconsideration of the National Ambient Air Quality Standards for Particulate Matter* (Feb. 5, 2024) (to be codified at 40 CFR Parts 50, 53, and 58), https://www.epa.gov/system/files/documents/2024-02/pm-naaqs-final-frn-pre-publication.pdf.
[59] *See* EPA, *Most Counties with Monitors Already Meet the Strengthened Particle Pollution Standard* (2022), https://www.epa.gov/system/files/documents/2024-02/2024-pm-naaqs-final-2020-22-dv-map.pdf; *see* EPA, *EPA Projects More than 99% of Counties would Meet the Revised Fine Particle Pollution Standard* (2023), https://www.epa.gov/system/files/documents/2024-02/2024-pm-naaqs-final-2032-projections-map.pdf; Appendix B at 5-7.





VII. <u>CARB's SRIA Failed to Analyze the Significant Costs that Will Be Associated with Adding a Sustainability Certification Requirement and with Potentially Excluding Significant Amounts of Ethanol from the California Market.</u>

The Standardized Regulatory Impact Assessment ("SRIA") of the Proposed Amendments fails to address the impacts of the proposed "sustainability requirements." The SRIA thus falls short of statutory requirements meant to ensure informed agency decision making and informed stakeholder participation.

Under Sections 11346.3 of the California Government Code, any "state agency proposing to adopt, amend, or repeal any administrative regulation shall assess the potential for adverse economic impact on California business enterprises and individuals, avoiding the imposition of unnecessary or unreasonable regulations or reporting, recordkeeping, or compliance requirements."[60] Among the issues that must be addressed in a SRIA, CARB must assess the competitive advantages or disadvantages for businesses currently doing business within the state, the increase or decrease of investment in the state and the incentives for innovation in products, materials, or processes, and the benefits to the health safety, and welfare of California residents.[61]

However, in the SRIA of the proposed LCFS Amendment, CARB does not discuss the proposed sustainability requirements or certification measures in any way. Indeed, it does not even mention these provisions of the proposal, let alone include the detailed analysis on the costs and benefits required by the statutes and regulations. The legal framework is meant to ensure that all regulatory proposals are accompanied by a SRIA that clearly outlines the potential economic impacts, including direct costs to regulated entities and the broader implications for the state's economy.

As discussed above, the potential costs to the supply chain and to California consumers of the sustainability regulations are significant. It may be costly to incentivize farmers to participate in sustainability certification programs. In addition, uncertified ethanol will lose the ability to generate LCFS credits, and instead will generate deficits. The additional CI costs for liquid fuel in addition to the reduced supply of low carbon fuel to the California market will further impose costs on the fuel supply chain. All of these costs will likely be passed down to California consumers, and none are analyzed in the SRIA.

In addition, the SRIA contains no discussion of the costs associated with the potential adverse environmental impacts of lower ethanol blending in California. There is no discussion of the greater PM and other emissions that may result if ethanol is made significantly more costly by the program.

By failing to include *any* discussion of the impacts of the proposed sustainability requirements or the certification systems for crop-based biofuel feedstocks, CARB cannot receive accurate stakeholder input on these issues, and the agency risks proceeding with the amendments without having an accurate or full picture of the economic or environmental impacts. CARB will be unable to assess and understand how the proposed sustainability requirements and certification systems will cause significant unnecessary costs in corn biofuel production without resulting in environmental benefits, and will also not have the stakeholder input critical to evaluating how the market will react to higher ethanol costs and the associated environmental impacts.

[60] Cal. Gov't Code § 11346.3(a) (West 2023).
[61] Cal. Gov't Code § 11346.3(c)(1) (West 2023).

VIII. If CARB does Implement Sustainability Requirements for Corn, it Must Also Provide a Mechanism for Crediting low-CI Farming Practices and Eliminate the Numerical ILUC penalty.

A. CARB should allow the use of certified farming data to calculate farm-by-farm CI scores.

As discussed in Appendix A, certifications systems like ISCC involve the collection of significant amounts of data related to farming practices such as fertilizer application, crop rotation, and soil organic carbon content. CARB is requiring that third-party auditors ensure that information regarding these variables be properly collected and documented.

Many of these factors are the same factors that are the biggest components of farm CI. At the end of the certification process, CARB will likely be in possession of fully verified data sets that allow calculations of farm-by-farm CI values.

Nonetheless, CARB has not proposed amendments that would allow biofuel producers to apply for CI scores that depart from regional agricultural averages. This undermines incentives that the LCFS program could be communicating to farmers to improve their practices. If CARB moves forward with the crop certification requirement, POET urges CARB to allow biofuel producers to use their certified data sets to calculate farm-specific CI scores.

B. The ILUC penalty would be duplicative and unnecessary if crop certification were required.

As described in Appendix A, the sustainability certification requirements that likely qualify under CARB's regulations were put into place in Europe in part because Europe does not apply a numerical land use change penalty to crop-based fuels. Instead of such a penalty, the certification systems deal with ILUC by requiring farmers to demonstrate that they are not impacting high carbon land, and that the feedstocks that most threaten high carbon lands are phased out of use. RED II and ISCC even provide a mechanism affirmatively demonstrating that crops present low ILUC risk.

CARB, on the other hand, is layering both approaches on top of each other. Even though risks from ILUC are already incorporated (in our view, in an overly conservative manner) into California CI scores, CARB is requiring validation that feedstock farmland has been used historically for agricultural purposes..

If CARB moves forward with crop certification, POET urges CARB to remove the ILUC penalty from certified farms. At a minimum, these farms should face a reduced penalty, and CARB should provide a pathway for demonstrating low ILUC risk to completely remove the ILUC penalty in a manner that is consistent with the EU.

IX. CARB Should Recognize Off-Site Renewable Energy Production for Bioethanol Plants.

California LCFS regulations prohibit the use of indirect accounting mechanisms to demonstrate production of fuel using low-CI process energy.[62] Although CARB's Proposed Amendments contemplate wholesale power contracting as part of a narrow set of fuel pathways (certain hydrogen pathways and direct air capture projects), these revisions do not extend to a fuller range of low carbon fuels like bioethanol. POET believes this is a missed opportunity, and we urge CARB to consider the revisions proposed by the Low-CI Power Coalition,[63] which would broadly incentivize the production of low-CI electricity. POET is a signatory to a separate comment letter submitted today by the Low-CI Power Coalition, and we refer CARB to the discussion presented in that letter, and the proposal submitted by the Coalition in June of 2023.

CONCLUSION

POET appreciates the opportunity to comment and looks forward to working with CARB to make the LCFS a continued success for California. If you have any questions, please contact me at Josh.Wilson@POET.com or (202)756-5612.

Sincerely,

Joshua P. Wilson
Senior Regulatory Counsel

[62] *See* 17 C.C.R. § 95488.8(h).
[63] *See Low CI Power Coalition Comment Letter* submitted by Noyes Law Corporation in LCFS Pre-Rulemaking workshop (June 6, 2023), available at: https://ww2.arb.ca.gov/system/files/webform/public_comments/3666/Low%20CI%20Power%20ARB%20LCFS%20Comments%20w%20Appendices%206%20June%202023.pdf.

APPENDIX A

RED II and ISCC Overview

RED II

RED II is the currently applicable version of the European Union Renewable Energy Directive, adopted in December 2018.[64] In general, RED II requires that in each future year EU member states must use increasing amounts of renewable energy sources, including biofuels.

Article 29 of RED II establishes a number of "sustainability and GHG emissions saving criteria" for biofuels, with the requirements vary with the specific feedstock involved (e.g., wastes and residues, forest biomass, or agricultural biomass). RED II establishes GHG reduction requirements for biofuels, with plants built below 2015 required to show a 50% production scaling up to new plants that are required to show a 65% reduction.

RED II specifically recognizes the concept of indirect land use change.[65] The EU also states that "the highest risks of indirect land-use change have been identified for biofuels, bioliquids and biomass fuels produced from feedstock for which a significant expansion of the production area into land with high-carbon stock is observed."[66] However, the Directive states that ILUC emissions are too uncertain to be incorporated into CI calculations.[67] RED II mitigates this concern by prohibiting crops grown on land with high-carbon stock from generating compliance credit.[68] A subsequent European Commission regulation further addresses the highest risk ILUC categories by establishing criteria for the highest ILUC risk feedstocks that will be unable to generate credits under RED II after 2030.[69] The only such feedstock identified in the Appendix to the regulation is palm oil.[70]

RED II also recognizes the existence of feedstocks that present low risk of ILUC.[71] The Directive sates, "[w]here there is evidence that [yield enhancing] measures have led to an increase of production going beyond the expected increase in productivity, biofuels, bioliquids and biomass fuels produced from such additional feedstock should be considered to be low indirect land-use change-risk biofuels, bioliquids and biomass fuels."[72]

RED II recognizes that some feedstocks present more significant ILUC concerns than others, and even suggests that EU states would be warranted in placing more stringent limits on the feedstocks of most concern such as crop-based oils.[73] Corn starch is not identified as a feedstock of high

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[64] Directive (EU) 2018/2001 of the European Parliament and of the Council [hereinafter "RED II"] (Dec. 18, 2018), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001.
[65] RED II at 94.
[66] *Id.*
[67] *Id.*
[68] *Id.* at 130-31.
[69] *See Commission Delegated Regulation (EU) 2019/807* at 2, 4 (March 13, 2019), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0807.
[70] *Supra* note 62, at 7.
[71] RED II at 104.
[72] *Id.* at 94.
[73] *Id.* at 126.

concern. As discussed above, an EU regulation designates palm oil as a feedstock that should be phased out by 2030. More generally, though, Annex VIII of RED II provisionally estimates an iLUC penalty of 55 g/MJ for oil, while assigning corn starch a 12 g/MJ ILUC value. In other words, the EU feels that oil crops present an ILUC risk of nearly 5 times higher than starch crops.

ISCC

ISCC describes itself as "a system for the implementation and certification of sustainable, traceable and deforestation-free supply chains."[74] As such, it aligns closely with the goals identified by CARB for the sustainability certification requirement in the purpose and rationale document. In that document, CARB identifies mitigation of deforestation risk as well as protection of high biodiversity value land and avoidance of land use change as key drivers behind the sustainability requirement.[75]

The ISCC certification system has been fully recognized by the EU since 2011. As stated by ISCC, "[t]he processes and procedures of ISCC are based on the binding requirements of the RED II."[76] There are two primary certification programs for biofuels established by ISCC: ISCC EU and ISCC Plus. ISCC EU is designed specifically to demonstrate RED II compliance while ISCC Plus is for non-EU markets. Nonetheless, the two frameworks are generally harmonized, and the ISCC EU documents generally serve as system requirements for ISCC Plus.[77] Thus, RED II is the source of the majority of substantive requirements to which the ISCC programs certify.

However, the ISCC certification programs do include ecological and social requirements that go beyond RED II.[78] ISCC notes that it may change its framework to accommodate changes in the legal requirements on which the ISCC is premised,[79] namely changes in the EU RED framework.

Significantly, ISCC requirements (whether ISCC EU or ISCC Plus) apply to the entire supply chain associated with biofuel.[80] This includes farmers, aggregators of crops, traders, and biofuel processors.[81] In the U.S. corn supply chain, this would requires thousands of entities to come into compliance and obtain certification under the ISCC framework.[82] Certifications require renewal on an annual basis.[83]

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[74] *ISCC EU 201 System Basics* at 8 (July 2, 2021), https://www.iscc-system.org/wpcontent/uploads/2022/05/ISCC_EU_201_System_Basics-v4.0.pdf.
[75] ISOR at 4, 32, 67.
[76] *ISCC EU System Basics* at 12.
[77] *ISCC Plus System Basics* at 7. There are some differences in the tracing and accountability requirements that are laid out in the ISCC Plus system documents. Additionally, the demonstration of GHG reduction requirements is voluntary for ISCC Plus, while it is required for ISCC EU in order to demonstrate RED II GHG reduction requirements. ISCC EU System Basics at 8. However, the vast majority of system documents and requirements are shared between the two certification systems.
[78] *ISCC EU System Basics* at 9.
[79] *Id.* at 11.
[80] *Id.* at 16.
[81] *Id.* at 25-29.
[82] There are some opportunities for group certification, but these are still premised on data for each and every part of the supply chain.
[83] *ISCC EU System Basics* at 34.

Consistent with the RED II standards for sustainability, ISCC seeks to address ILUC by excluding from ISCC certification crops grown on land with high carbon stock.[84] ISCC EU 202-1 deals almost exclusively with this requirement, and also applies to ISCC Plus. ISCC also provides a framework for demonstrating that crops present low ILUC risk.[85]

Aside from addressing ILUC issues, the ISCC certification addresses issues related to other aspects of farming that impact CI. For example, ISCC requires significant analysis of the amount of fertilizer applied to fields and the maintenance of records to support the analysis, the maintenance of soil quality indicators, use of agricultural wastes, and calculation of soil organic matter content.[86] Many of the variables tracked by the ISCC are the very variables that most impact the CI of farming.

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[84] *ISCC EU 202-1, Agricultural Biomass Principle 1*, at 7 (Jan. 2024), https://www.iscc-system.org/wp-content/uploads/2024/01/ISCC_EU_202-1_Agricultural-Biomass_ISCC-Principle-1_v4.1_January2024.pdf.
[85] *See ISCC Plus Add-on 202-07, Low ILUC-Risk Feedstock Certification* (July 2023), https://www.iscc-system.org/wp-content/uploads/2023/11/ISCC_PLUS_lowILUC_V1.0_July2023_Final.pdf.
[86] *ISCC EU 202-2 Agricultural Biomass: ISCC Principles 2-6*, at 12-15 (Dec. 1, 2022), https://www.iscc-system.org/wp-content/uploads/2022/08/202_2_Agricultural-Biomass_ISCC-Principles-2-6_v1.1_August_2.pdf.

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February 20, 2024

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Comments of David MacIntosh[1,2], Brittany Schwartz[1]
[1] Environmental Health & Engineering, Inc., Newton MA
[2] Harvard T.H. Chan School of Public Health, Boston, MA

RE: Comments on 2024 Proposed Low Carbon Fuel Standard Amendments

We at Environmental Health & Engineering, Inc. (EH&E) are a multi-disciplinary team of environmental health scientists and engineers with expertise in measurements, models, data science, life cycle assessment (LCA), and public health. Members of our team conducted a state-of-the-science review of the carbon intensity (CI) for corn ethanol in the United States (U.S.)[1] and a comprehensive assessment of the impacts of corn ethanol fuel blends on tailpipe emissions.[2,3]

We submit this letter to the California Air Resources Board (CARB) in response to the 2024 Proposed Low Carbon Fuel Standard (LCFS) Amendments.[4]

BACKGROUND INFORMATION

The LCFS Regulation was created after the California Global Warming Solutions Act of 2006, with a goal of reducing the CI of the transportation fuel pool used in California. CARB has recently released a draft of its 2024 update to the regulation. Appendix A-1 of the Proposed Regulation Order contains the proposed amendments and was updated on January 2, 2024.

Within these proposed amendments is a requirement[5] that all crop-based and forestry-based feedstocks used for LCFS fuel pathways must maintain continuous third-party sustainability

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[1] Scully MJ, Norris GA, Alarcon Falconi TM, MacIntosh DL. 2021a. Carbon intensity of corn ethanol in the United States: state of the science. *Environmental Research Letters*, 16(4), pp.043001.
[2] Kazemiparkouhi F, Alarcon Falconi TM, Macintosh DL and Clark N. 2022. Comprehensive US database and model for ethanol blend effects on regulated tailpipe emissions. *Sci Total Environ*, 812, pp.151426.
[3] Kazemiparkouhi F, Karavalakis G, Alarcon Falconi TM, Macintosh DL and Clark N. (in press). Comprehensive US database and model for ethanol blend effects on air toxics, particle number, and black carbon tailpipe emissions. *Atmospheric Environment: X*.
[4] CARB, Low Carbon Fuel Standard, https://ww2.arb.ca.gov/rulemaking/2024/lcfs2024
[5] Proposed as line (g) under Section 95488.9. Special Circumstances for Fuel Pathway Applications.

certification, beginning on January 1, 2028.[6] Biofuels using feedstocks that fail to obtain the certification will be penalized by being assigned the same total CI score as ultra-low sulfur diesel (ULSD). As we share in this letter, our team has concerns about the potential outcomes of this proposed certification requirement. In particular, the cost of the certification process and CI penalty may result in less ethanol blending in California fuels, which risks the air quality and climate benefits offered by corn starch ethanol.

POTENTIAL OUTCOMES OF THE PROPOSED AMENDMENTS

As mentioned, an element of the proposed amendments would require crop-based feedstocks used for fuel pathways to receive a sustainability certification or face a CI penalty.[7] While we appreciate that CARB recognizes the importance of emissions reductions through sustainable agricultural practices, we are concerned that the certification requirement has not been assessed for impact and has the potential to result in outcomes that reduce ethanol levels in California's fuel.

Predicting the implications of the certification requirement involves studying a complex mix of economic market dynamics, fuel policies, and refinery priorities/capabilities.[8] Based on our review of the proposed amendments and supporting documents, CARB has not conducted an analysis to determine these impacts. In this section, we bring up considerations that reveal that a certification requirement should be preceded by an in-depth study of its regulatory impacts.

The requirements of the sustainability certification process will likely pose a new cost on the feedstock supply chain for biofuels that are an integral component of transportation fuels in California. Raising the cost of a key element of fuel blends could have several impacts. For one, at least a portion of the costs may be passed on to California consumers as increases in the retail price of fuel blends at the pump.

In addition, higher prices of ethanol could reshuffle the gasoline blending dynamic in California. The current 10% ethanol/CARBOB fuel blend is premised on the availability of relatively inexpensive ethanol that also generates CI credits. Higher costs of ethanol might incentivize the markets and fuel producers to reconfigure their refineries and distribute blends that contain more aromatics or alkylates as octane substitutes for ethanol. The upshot is that the certification requirement could disrupt markets or prompt refineries to reconsider their fuel blends, potentially resulting in less ethanol blending.

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[6] CARB. Appendix A-1. Proposed Regulation Order. Proposed Amendments to the Low Carbon Fuel Standard Regulation. p 166. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/lcfs_appa1.pdf

[7] CARB. Appendix A-1. Proposed Regulation Order. Proposed Amendments to the Low Carbon Fuel Standard Regulation. p. https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/lcfs_appa1.pdf

[8] CARB. 2023. Appendix C-1: Standardized Regulatory Impact Assessment (SRIA). https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2024/lcfs2024/appc-1.pdf

Changing the blend to reduce ethanol content would have adverse air quality and climate impacts that we discuss next in this letter. By making it more challenging to incorporate ethanol into fuel blends, the proposed certification jeopardizes the air quality, public health, and climate benefits of ethanol. In the sections that follow, we introduce these benefits and other considerations.

ETHANOL FUEL BLENDS AND TAILPIPE EMISSIONS

Two 2022 publications by our team and a 2022 report by the University of California – Riverside (UCR) are among the literature to indicate that increasing ethanol content in fuels decreases emissions of certain air pollutants. The uncertainty around the implications of the proposed certification precludes our team from modeling and comparing the emissions of a specific fuel blend that could hypothetically emerge on the market through the replacement of some ethanol content with a substitute. Instead, in this section we present findings of the general trend that fuel blends with higher ethanol content have lower emissions of particulate matter (PM) and other air pollutants when compared with blends containing less ethanol.

Recent Studies from Our Team

Members of our team led the Kazemiparkouhi et al. (2022a)[9] and Kazemiparkouhi et al. (2022b)[10] studies, which are the first large-scale analyses of data from light-duty vehicle emissions studies to examine real-world impacts of ethanol-blended fuels on air pollutant emissions, including PM, NOx, CO, and THC[11], as well as BTEX (benzene, toluene, ethylbenzene, xylene) and 1,3-butadiene.[12]

In each study, we used similar approaches. We extracted data from a comprehensive set of emissions and market fuel studies conducted in the U.S. Using these data, we (1) estimated the composition of market fuels for different ethanol volumes and (2) developed regression models to estimate the impact of changes in ethanol volumes in market fuels on air pollutant emissions for different engine types and operating conditions. Importantly, our models estimated these changes accounting for not only ethanol volume fraction, but also aromatic volume fraction, 90% volume distillation temperature (T90), and Reid Vapor Pressure (RVP). Further, our models examined the impacts of ethanol fuels on emissions under both cold start and hot stabilized running conditions and for gasoline-direct injection engines (GDI) and port-fuel injection (PFI) engine types. In doing so, our two papers provided important new information about real-world market fuels and their corresponding air pollutant emissions, as highlighted below.

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[9] Kazemiparkouhi, F., Alarcon Falconi, T.M., Macintosh, D.L., and Clark, N. 2022a. Comprehensive U.S. database and model for ethanol blend effects on regulated tailpipe emissions. Sci Total Environ, 812, pp.151426.
[10] Kazemiparkouhi, F., Karavalakis, G., Alarcon Falconi, T.M., Macintosh, D.L., and Clark, N. 2022b. Comprehensive US database and model for ethanol blend effects on air toxics, particle number, and black carbon tailpipe emissions. Atmospheric Environment: X, 16, 100185.
[11] Kazemiparkouhi et al., 2022a.
[12] Kazemiparkouhi et al., 2022b.

- Aromatic levels in market fuels decreased by ~7% by volume for each 10% by volume increase in ethanol content, as discussed earlier.
- PM emissions decreased by 15-18% on average for each 10% increase in ethanol content under cold-start conditions.
- Emissions of CO and THC generally decreased with increasing ethanol fuel content under cold running conditions, while NOx emissions did not change.
- Air toxic emissions showed lower BTEX, 1-3 butadiene, black carbon, and particle number emissions with increasing ethanol fuel content.

2022 UCR Study

Additional evidence of this trend comes from a report prepared for CARB by UCR.[13] This study assessed the impact of E15 (splash-blended from E10) on air pollutant emissions for twenty current technology Tier 3 or California LEV-III, SULEV exhaust emissions standards vehicles. The authors found that switching from E10 to E15 reduced PM emissions by 18%, with cold-start emissions being reduced by 17%.

Further, emissions of CO and THC significantly decreased with increasing ethanol fuel content, while NO_x emissions did not change. Air toxic emissions also showed lower ethylbenzene, m/p-xylene, o-xylene, and solid particle number emissions with increasing ethanol fuel content while 1,3-butadiene, benzene, and toluene emissions did not change.

STRENGTHENED NATIONAL AMBIENT AIR QUALITY STANDARDS

The prospect of losing the PM emissions benefit of 10% ethanol blends in light-duty vehicle fuel has implications for the ability of California to comply with the strengthened National Ambient Air Quality Standard (NAAQS) for fine particulate matter, known as $PM_{2.5}$, announced by the U.S. Environmental Protection Agency (EPA) on February 7, 2024.[14]

The updated NAAQS lowers the upper limit on annual average $PM_{2.5}$ concentrations from 12 micrograms per cubic meter (µg/m^3) to 9 µg/m^3. $PM_{2.5}$ is widely recognized as a cause of premature mortality, cardiovascular disease, respiratory disease, asthma exacerbation and other

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[13] Karavalakis G, Durbin TD, Tang T. 2022. Comparison of Exhaust Emissions Between E10 CaRFG and Splash Blended E15. Final Report. Riverside, CA: California Air Resources Board (CARB), Growth Energy Inc./Renewable Fuels Association (RFA), and USCAR.

[14] EPA finalizes stronger standards for harmful soot pollution, significantly increasing health and clean air protections for families, workers, and communities. U.S. Environmental Protection Agency web page. Accessed February 9, 2024.

adverse effects in humans. Nationwide achievement of the new $PM_{2.5}$ NAAQS is estimated to prevent 4.500 premature deaths and yield up to $46 billion in net health benefits in 2032.[15]

Notably, $PM_{2.5}$ concentrations in 29 of the 58 California counties for 2020 – 2022 do not meet the new NAAQS of 9 $\mu g/m^3$.[16] These counties are listed in Table 1. Moreover, 23 counties in the state, including 21 of those in Table 1 plus Calaveras and Ventura Counties, are not projected to meet the updated standard by 2032, its first year of enforcement, despite the substantial emissions reductions expected to result from full implementation of existing legislation and incentives.[17,18]

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[15] U.S. Environmental Protection Agency. 2024a. Final Regulatory Impact Analysis for the Reconsideration of the National Ambient Air Quality Standards for Particulate Matter. EPA-452/R-24-006. Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, Research Triangle Park, NC.

[16] U.S. Environmental Protection Agency. 2024b. Fine Particle Concentrations for Counties with Monitors Based on Air Quality Data from 2020 - 2022. Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, Research Triangle Park, NC.

[17] U.S. Environmental Protection Agency. 2024b.

[18] U.S. Environmental Protection Agency. 2024c. EPA Projects 52 Counties Would Not Meet the Strengthened Standard in 2032. Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, Research Triangle Park, NC.

Table 1 Design values and reductions in annual average concentrations of fine particulate matter ($PM_{2.5}$) in California counties that do not currently meet the strengthened National Ambient Air Quality Standard (NAAQS) of 9 micrograms per cubic meter (µg/m^3).

County	2020 – 2022 Design Value for Annual $PM_{2.5}$ (µg/m^3)[a]	$PM_{2.5}$ Reduction Needed to Comply with Strengthened NAAQS (µg/m^3)	Percentage Change in $PM_{2.5}$ (%)
Alameda	9.4	0.4	-4.4%
Butte	11.6	2.6	-28.9%
Colusa	10.5	1.5	-16.7%
Contra Costa	10.0	1.0	-11.1%
Fresno	17.5	8.5	-94.4%
Imperial	11.1	2.1	-23.3%
Kern	18.8	9.8	-108.9%
Kings	16.6	7.6	-84.4%
Los Angeles	13.4	4.4	-48.9%
Madera	13.2	4.2	-46.7%
Mendocino	11.1	2.1	-23.3%
Merced	12.3	3.3	-36.7%
Mono	19.5	10.5	-116.7%
Orange	11.2	2.2	-24.4%
Placer	10.9	1.9	-21.1%
Plumas	17.0	8.0	-88.9%
Riverside	13.6	4.6	-51.1%
Sacramento	11.7	2.7	-30.0%
San Bernadino	14.0	5.0	-55.6%
San Diego	10.0	1.0	-11.1%
San Joaquin	12.3	3.3	-36.7%
Santa Clara	10.7	1.7	-18.9%
Shasta	9.3	0.3	-3.3%
Siskiyou	11.6	2.6	-28.9%
Solano	9.4	0.4	-4.4%
Stanislaus	14.3	5.3	-58.9%
Sutter	13.8	4.8	-53.3%
Tehama	9.9	0.9	-10.0%
Tulare	18.4	9.4	-104.4%

[a] U.S. Environmental Protection Agency. 2024b. Fine Particle Concentrations for Counties with Monitors Based on Air Quality Data from 2020 - 2022. Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, Research Triangle Park, NC.

EPA projects that annual emissions of primary $PM_{2.5}$ in these 23 counties will need to decrease by 43 (Ventura) to 2,551 (Los Angeles, Riverside, San Bernadino) tons.[19] The magnitude of the emissions reductions necessary to meet the strengthened NAAQS indicates that CARB should ensure all practical measures are taken to protect existing avoided $PM_{2.5}$ emissions including current ethanol fuel blends. On-road motor vehicles are the third largest source category of $PM_{2.5}$ emissions in the South Coast Basin of California, including Los Angeles, Riverside, and San Bernadino counties, which reinforces the important benefits of current ethanol blends compared

[19] U.S. Environmental Protection Agency. 2024a. Table 2A-14, p. 155-158.

to lower ethanol blends that could be a consequence of the proposed requirement for feedstock certification.[20]

Environmental Justice Communities

The benefits to air quality and public health associated with higher ethanol fuels may be particularly important for Environmental Justice Communities (EJCs). EJCs are predominantly located in urban neighborhoods with high traffic density and congestion; these communities are thus exposed to disproportionately higher concentrations of PM emitted from motor vehicle tailpipes.[21,22,23] For example, in New York, people of color are exposed to more $PM_{2.5}$ from light-duty gasoline vehicles and heavy-duty diesel vehicles than average (+35% and +42%).[24]

This unequal impact is seen on a national level within the Regulatory Impact Analysis for the new PM NAAQs, where EPA found that, on average, "…Asian, Black, Hispanic, less educated, unemployed, uninsured, linguistically isolated, below the poverty line populations live in areas with higher annual average PM2.5 concentrations than the reference population." [25] The strengthened NAAQS is projected to have disproportionately beneficial impacts on EJC,[26] which underscores the importance of maintaining 10% and higher ethanol blends in California over lower ethanol blend concentrations.

Further, vehicle trips within urban EJCs tend to be short in duration and distance, with approximately 50% of all trips in dense urban communities under three miles long.[27,28,29] As a result, a large proportion of urban vehicle operation occurs under cold-start conditions,[30] when

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[20] U.S. Environmental Protection Agency. 2024a. Figure 2-27, p. 90.
[21] Bell, M. L., & Ebisu, K. (2012). Environmental inequality in exposures to airborne particulate matter components in the United States. *Environmental Health Perspectives*, *120*(12), 1699–1704. https://doi.org/10.1289/ehp.1205201
[22] Clark, L. P., Millet, D. B., & Marshall, J. D. (2014). National patterns in environmental injustice and inequality: Outdoor NO2 air pollution in the United States. *PLoS One*, *9*(4), e94431. https://doi.org/10.1371/journal.pone.0094431
[23] Tian, N., Xue, J., & Barzyk, T. M. (2013). Evaluating socioeconomic and racial differences in traffic-related metrics in the United States using a GIS approach. *J Expo Sci Environ Epidemiol*, *23*(2), 215–222. https://doi.org/10.1038/jes.2012.83
[24] Tessum, C. W., Paolella, D. A., Chambliss, S. E., Apte, J. S., Hill, J. D., & Marshall, J. D. (2021). PM2.5 polluters disproportionately and systemically affect people of color in the United States. *Science Advances*, *7*(18), eabf4491. https://doi.org/10.1126/sciadv.abf4491
[25] U.S. Environmental Protection Agency. 2024a. p. 333.
[26] U.S. Environmental Protection Agency. 2024a. Chapter 6.
[27] de Nazelle, A., Morton, B. J., Jerrett, M., & Crawford-Brown, D. (2010). Short trips: An opportunity for reducing mobile-source emissions? *Transportation Research Part D: Transport and Environment*, *15*(8), 451–457. https://doi.org/10.1016/j.trd.2010.04.012
[28] Reiter, M. S., & Kockelman, K. M. (2016). The problem of cold starts: A closer look at mobile source emissions levels. *Transportation Research Part D: Transport and Environment*, *43*, 123–132. https://doi.org/10.1016/j.trd.2015.12.012
[29] US DOT. (2010). *National Transportation Statistics*. Bureau of Transportation Statistics.
[30] de Nazelle et al. 2010.

PM emissions are highest. Given the evidence that ethanol-blended fuels substantially reduce PM during cold-start conditions,[31] it follows that ethanol-blended fuels may present an effective method to reduce air pollution-related health risks for EJCs.

Additionally, while the market share of gasoline-powered light-duty vehicles is expected to decrease over the next 10 years due to electric vehicles (EVs), they still account for a majority of the vehicles driven by the US population. EVs also have higher upfront costs than gasoline-powered vehicles ($18,000 higher on average)[32] which may limit their market penetration until prices become more comparable.[33] Given the financial barriers to acquiring an EV and the disproportionate exposure to traffic pollution for EJCs,[34] alternatives such as using higher ethanol blends may provide significant benefits to these communities.

ETHANOL SUPPORTS CARB'S GREENHOUSE GAS REDUCTION GOALS

Another reason for concern about the outcomes of the proposed amendments is that reducing ethanol content in fuels goes against CARB's greenhouse gas (GHG) reduction goals.

In addition to lower emissions of key health-relevant pollutants, such as PM and BTEX, and associated benefits to air quality and health, studies have shown that higher ethanol fuel blends also provide significant GHG reductions.

To quantify these GHG reductions, we conducted a state-of-the-science review of the carbon intensity (CI) for corn ethanol in the US, applied objective criteria applicable to the US regulatory context, and derived an evidence-based central CI estimate and credible range as of 2020.[35] We found that assessments of GHG intensity for corn ethanol have decreased by approximately 50% over the prior 30 years and converge on a current central estimate value of approximately 51 grams of carbon dioxide equivalent emission per megajoule (gCO_2e/MJ), which is about 46% lower than the average CI for neat gasoline. This trend is further evidenced by more recent corn starch ethanol results generated by the Argonne National Laboratory's (ANL) Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model (GREET), with a central estimate of 55.6 gCO_2e/MJ in 2021 and 51.3 gCO_2e/MJ in 2022.[36] The decrease in GHG intensity is attributable to updates in modeling systems and input data that reflect market-driven changes that resulted in more efficient corn production and energy consumption at ethanol refineries, as well as market-based analyses of indirect land use change

[31] Kazemiparkouhi et al. 2022a.
[32] J.D. Power E-Vision Intelligence Report, October 2023.
[33] Ibid.
[34] Tessum CW, Paolella DA, Chambliss SE, Apte JS, Hill JD, Marshall JD. 2021. PM2. 5 polluters disproportionately and systemically affect people of color in the United States. Science Advances, 7(18).
[35] Scully et al. 2021.
[36] Argonne National Laboratory. The Greenhouse Gases, Regulated Emissions, and Energy Use in Technologies Model. 2021 and 2022.

(iLUC). Estimates for corn farming and production of ethanol are consistent between the most recent estimates from the CARB, EPA, ANL, and our analysis. The primary difference across the CI estimates for corn ethanol relates to iLUC.

iLUC Estimates

As mentioned, iLUC represents the main discrepancy between various CI estimates for corn starch ethanol. Looking closer, analyses relying on updated models and inputs return lower iLUC impacts than prior work.

The plot in Figure 1 presents current iLUC estimates for corn ethanol in comparison to prior and now superseded estimates from EPA in 2010 and CARB in 2015/2018. The figure, which is based on updates to Figure 1 in Scully et al. 2021, includes iLUC estimates from the most current relevant and applicable modeling efforts in the U.S. (shown in blue) and in Europe (shown in red).[37, 38] For reference, we also include the U.S. Department of Agriculture (USDA), Washington State, and Oregon State studies, which are based on review of primary LUC analyses. Note that the figure does not include a 2022 publication by Lark et al,[39] as this paper has been heavily critiqued and should not be relied on. Flaws of that study have been documented in our response to the paper,[40] critiques by researchers at ANL,[41,42] and a comment by USDA.[43]

We see from Figure 1 that the four commonly relied upon models—GTAP-BIO, FAPRI-CARD, MIRAGE, and GLOBIOM—provide current estimates of iLUC GHG impacts that are considerably lower than the earlier results from EPA and CARB.

[37] Scully et al. 2021a.

[38] Results from Plevin et al. 2015, the prominent application of GCAM for corn starch ethanol iLUC, are not included because the authors report ranges of iLUC values and later explain that the ranges are not predictions but instead were generated to understand model sensitivity to selected parameters. In that paper, the uncertainty analysis aims to determine the relative influence of individual parameter uncertainty on overall uncertainty, not reduce uncertainty.

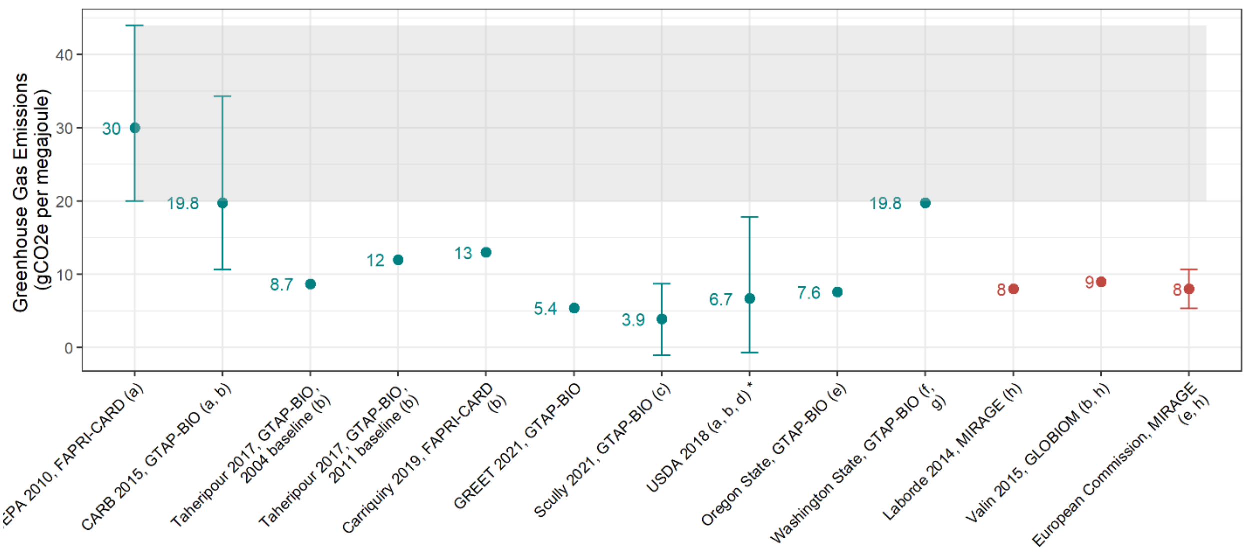
[39] Lark, T.J., Hendricks, N.P., Smith, A., Pates, N., Spawn-Lee, S.A., Bougie, M., Booth, E.G., Kucharik, C.J. and Gibbs, H.K., 2022. Environmental outcomes of the US renewable fuel standard. Proceedings of the National Academy of Sciences, 119(9), p.e2101084119.

[40] Alarcon Falconi et al., 2022.

[41] Taheripour, F., Mueller, S., Kwon, H., Khanna, M., Emery, I., Copenhaver, K., Wang, M. and CropGrower, L.L.C. 2022b. Comments on "Environmental Outcomes of the US Renewable Fuel Standard".

[42] Taheripour, F., Mueller, S., Kwon, H., Khanna, M., Emery, I., Copenhaver, K., Wang, M. and CropGrower, L.L.C., 2022c. Response to comments from Lark et al. regarding Taheripour et al. March 2022 comments on Lark et. al. original PNAS paper.

[43] USDA. 2022. Technical Memorandum: Review of Recent PNAS Publication on GHG Impacts of Corn Ethanol. Available from: https://www.usda.gov/sites/default/files/documents/USDA-OCE-Review-of-Lark-2022-For-Submission.pdf



a Uses older versions of the model
b Indirect and direct land use change
c Partially based on a review of primary land use change analyses
d Based on a review of primary land use change analyses using multiple models
e Policy based on primary land use change analyses
f Proposed policy based on primary land use change analyses
g Based on CARB 2015 analysis
h Adjusted to a 30-year, amortization period
* Includes CARB 2015 LUC as the upper range

Figure 1 Comparison of EPA's iLUC estimates with relevant most recent studies from the U.S. (teal) and Europe (red)

Several publications also recognize this downward trend in iLUC estimates for corn starch ethanol over the last decade.[44, 45, 46, 47] This agreement can be attributed to model and data improvements, including data that reflect the uptake of sustainable farming practices.

COMPARING LAND USE IMPACTS OF STARCHES AND OILS

The discussion of iLUC impacts underscores the importance of prioritizing feedstocks with minimal environmental footprints in biofuel production. In a 2015 report generated for the European Commission, Valin[48] compares the LUC impacts and emissions of starch-based crops

[44] Lee U, Hoyoung K, Wu M, Wang M. 2021. Retrospective analysis of the U.S. corn ethanol industry for 2005-2019: implications for greenhouse gas emission reductions. Biofuels, Bioproducts & Biorefining, 15(5), pp.1318-1331.

[45] Dunn JB, Mueller S, Kwon H-Y and Wang MQ. 2013. Land-use change and greenhouse gas emissions from corn and cellulosic ethanol. Biotechnology for Biofuels, 6(1), pp.1-3.

[46] Taheripour F, Mueller S and Kwon H. 2021a. Appendix A: supplementary information to response to 'How robust are reductions in modeled estimates from GTAP-BIO of the indirect land use change induced by conventional biofuels?' Journal of Cleaner Production., 310, pp.127431.

[47] Carriquiry M, Elobeid A, Dumortier J and Goodrich R. 2019. Incorporating sub-national Brazilian agricultural production and land-use into U.S. biofuel policy evaluation. Applied Economic Perspectives and Policy, 42, pp.497-523.

[48] Valin, H., Peters, D., van den Berg, M., Frank, S., Havlík, P., Forsell, N., Hamelinck, C. N., Leclère, D., & Gusti, M. (2015). The land use change impact of biofuels consumed in the EU: Quantification of area and greenhouse gas impacts (No. JRC95883). European Commission, Joint Research Centre.

to vegetable oils, illustrating that starch crops, like corn, generally demonstrate lower LUC impacts and emissions compared to vegetable oils. For starches as a group, Valin assigns LUC emissions of 29 gCO_2/MJ, while the vegetable oil group is assigned over three times that value: 101 gCO_2/MJ. Looking specifically at corn ethanol, Valin estimates a LUC impact of 14 gCO_2/MJ. Meanwhile, the LUC emissions from palm oil biodiesel are estimated to be 231 gCO_2/MJ.

A 2013 study[49] simulates the direct LUC impact of three palm oil expansion scenarios in Brazil, differentiated by the level of environmental enforcement in the area. Noting that the results are an estimate of direct LUC only (i.e, these do not include iLUC), the authors estimate a direct LUC impact of 14 gCO_2e/MJ for palm oil in a strict enforcement scenario, 60 gCO_2e/MJ with some environmental enforcement, and 84 gCO_2e/MJ given no environmental enforcement.

These findings align with the broader literature, which emphasizes the detrimental environmental costs associated with the expanded use and production of vegetable oils, especially palm oil, including intensive land use requirements, deforestation, and biodiversity loss compared to starch-based biofuels.[50,51,52] However, our initial exploration of the literature on palm oil impacts shows that even recent studies[53] tend to call on older values for the crop's LUC emissions in a biofuel context. This indicates a need for further research to capture and update the LUC of palm oil, as other authors have expressed.[54]

Alternate iLUC Approaches

The European Union Renewable Energy Directive II (EU RED II) framework offers an informative and global perspective on addressing the environmental impacts of biofuel feedstocks. Notably, the EU RED II refrains from quantifying iLUC impacts of biofuel feedstocks due to the complexities in modeling and predicting iLUC. Instead, the EU RED II categorizes feedstocks into low, medium, and high-risk categories based on their potential

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[49] Yui, S. and Yeh, S., 2013. Land use change emissions from oil palm expansion in Pará, Brazil depend on proper policy enforcement on deforested lands. Environmental Research Letters, 8(4), p.044031.

[50] Koh, L. P., & Wilcove, D. S. (2008). Is oil palm agriculture really destroying tropical biodiversity? Conservation Letters, 1(2), 60–64. https://doi.org/10.1111/j.1755-263X.2008.00011.x

[51] Gaveau, D. L. A., Sheil, D., Husnayaen, S., Salim, M. A., Arjasakusuma, S., Ancrenaz, M., Pacheco, P., & Meijaard, E. (2013). Rapid conversions and avoided deforestation: Examining four decades of industrial plantation expansion in Borneo. Scientific Reports, 3(1), Article 3370.

[52] Taheripour, F. and Tyner, W.E., 2020. US biofuel production and policy: implications for land use changes in Malaysia and Indonesia. Biotechnology for biofuels, 13(1), pp.1-17.

[53] Meijaard, E., Brooks, T.M., Carlson, K.M., Slade, E.M., Garcia-Ulloa, J., Gaveau, D.L., Lee, J.S.H., Santika, T., Juffe-Bignoli, D., Struebig, M.J. and Wich, S.A., 2020. The environmental impacts of palm oil in context. Nature plants, 6(12), pp.1418-1426.

[54] Cooper, H.V., Evers, S., Aplin, P., Crout, N., Dahalan, M.P.B. and Sjogersten, S., 2020. Greenhouse gas emissions resulting from conversion of peat swamp forest to oil palm plantation. Nature communications, 11(1), p.407.

environmental impacts.[55] Corn and other starches are typically classified as low or medium risk, while palm oil is considered high risk due to its significant LUC impacts.[56] Other vegetable oils like soybean oil may also receive high-risk categorization under the EU RED II due to similar environmental concerns.[57,58,59]

EU RED II regulation of feedstocks favors low-risk biofuels, applying stricter criteria to those deemed high-risk due to their environmental impacts. Starches, including corn starch, are generally categorized as low or medium risk within this framework.[60] As such, issuing broad California regulatory efforts that capture starches like corn starch may not be the most effective approach to promote sustainable biofuel production practices and to mitigate adverse environmental consequences associated with biofuel feedstocks given their relatively lower environmental effects. Instead, CARB may consider policies that focus on vegetable oil feedstocks and their larger LUC impacts.

Limited Availability of Vegetable Oils

Additionally, the limited availability of recycled vegetable oils can indirectly incentivize the razing of forests for conversion to vegetable oil plantations, especially palm oil plantations, further exacerbating environmental concerns associated with biofuel production. Recycled vegetable oils, derived from used cooking oil and other waste sources, are considered a sustainable feedstock for biofuel production due to their potential to reduce GHG emissions and minimize competition with food crops.[61,62] However, their availability is constrained by factors including collection infrastructure, processing capacity (including pretreatment needs to reduce free fatty acids), and market demand.[63,64] The low availability of recycled vegetable oils may incentivize producers to seek out virgin vegetable oils, contributing to further negative environmental impacts.[65,66] Specifically, the International Council on Clean Transportation

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[55] European Union. (2018). Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32018L2001
[56] EU Directive 2018/2001
[57] EU Directive 2018/2001
[58] European Federation for Transport & Environment (2022) Fueling our Crises, November 4, 2022. Soy_Study_TE_2022_final_embargoed_Friday_4_Nov-1.pdf (transportenvironment.org)
[59] Carlson, K.M. & Garret, R.D. (2018). Environmental Impacts of Tropical Soybean and Palm Oil Crops. Environmental Science. https://doi.org/10.1093/acrefore/9780199389414.013.234
[60] EU Directive 2018/2001
[61] Valin et al., 2015
[62] Gaveau et al., 2013
[63] LMC International/GlobalData. USO Supply Outlook. https://cleanfuels.org/wp-content/uploads/GlobalData_UCO-Supply-Outlook_Sep2023.pdf
[64] Banga, S. and Pathak, V.V., 2023. Biodiesel production from waste cooking oil: a comprehensive review on the application of heterogenous catalysts. Energy Nexus, p.100209.
[65] Koh & Wilcove, 2008
[66] Gaveau et al., 2013

(ICCT) warns that there is potential for waste oil fraud, where virgin palm oil and soy oil are disguised as waste oil.[67] ICCT reports that cases of waste fraud have already been taken to U.S. federal courts.

To mitigate the environmental impacts posed by high-risk feedstocks like palm oil, policymakers can promote more sustainable biofuel feedstocks such as corn starch.[68,69]

EXISTING SUSTAINABILITY PRACTICES

In the earlier section about corn ethanol's support for GHG reduction goals, we mention that the total CI of ethanol has declined due to improvements in modeling estimates and market-driven efficiency in both corn production and energy consumption at ethanol refineries. Here, we discuss the possibilities of carbon reduction strategies and technologies that are currently in use in agriculture and at ethanol plants. These improvements have already reduced the CI of the feedstock and ethanol production stages for various farms and plants and have the potential for further reductions across the industry.

During the summer of 2021, the Renewable Fuels Association (RFA) sent a letter to President Biden committing its members to ambitious carbon emissions targets.[70] Signed by dozens of ethanol producers, the letter sets two goals: 1) reduce ethanol's average CI to about 30gCO_2e/MJ by 2030 (a reduction of around 15g/MJ from the current average RFA presents) and 2) on average, achieve net carbon neutrality for ethanol by 2050.

A February 2022 report prepared by Informed Sustainability Consulting (ISC) for the RFA assesses the feasibility for the ethanol industry to meet its stated goals.[71] The report first establishes a baseline scenario that only considers gradual yield improvements and efficiency advancements. The authors estimate that this business-as-usual scenario would result in a 7.1 gCO_2e/MJ reduction in the ethanol CI between 2020 and 2050, not reaching RFA's targets. Next, ISC analyzes the potential impact, estimated cost, and technology readiness level of 29 individual "emission reduction actions" that can be adopted along the supply chain. The authors then arrange these actions into five viable pathways for ethanol to reach net zero by 2050.

[67] ICCT. 2023. U.S. Biofuel Demand and the Potential for Used Cooking Oil from Major Asian Exporting Countries. https://theicct.org/wp-content/uploads/2023/02/US-UCO-potential_fs_final.pdf
[68] EU Directive 2018/2001
[69] Mongabay. (2011, November 8). Palm oil biofuel from peatlands has big climate impact, finds study. Mongabay Environmental News. https://news.mongabay.com/2011/11/pam-oil-biofuel-from-peatlands-has-big-climate-impact-finds-study/
[70] https://d35t1syewk4d42.cloudfront.net/file/1272/RFA-Net-Zero-Commitment-Letter-to-President-Biden-.pdf
[71] ISC. 2022. Pathways to Net-Zero Ethanol: Scenarios for Ethanol Producers to Achieve Carbon Neutrality by 2050. https://d35t1syewk4d42.cloudfront.net/file/2146/Pathways%20to%20Net%20Zero%20Ethanol%20Feb%202022.pdf

The ISC report describes a "core pathway" that balances impact, cost, and readiness; the other pathways prioritize a single factor, such as cost. Each pathway contains up to a dozen actions, and in each pathway, ethanol reaches net zero by 2050. The core pathway achieves the majority of its success through carbon capture and sequestration (CCS) at ethanol plants, along with renewable energy use at ethanol plants.[72] Specifically, the authors note that "Implementing CCS can offset more GHG emissions than are emitted by all of a facility's energy use and non-corn input purchases operations combined."[73] The core pathway also incorporates actions by corn farmers (e.g., "75% adoption of renewable electricity and 75% increase in reduced tillage practices"[74]), but the authors note that combining the supplier elements of the core pathway totals a reduction of under 1 gCO_2e/MJ.

To understand progress toward emissions goals, RFA issued a survey to its members in March 2023.[75] RFA reports that "nearly all" member producers responded, representing small and large facilities across 12 states.[76] When presented with 10 specific improvements, all plants responded that they have incorporated at least one of these efforts since 2015/2016, and "most facilities adopted more than one of these technologies and practices". [77] Over half of the respondents have invested in two specific efforts: high-efficiency motors and fermentation efficiencies. Seventy-nine percent of plants indicated they intend to adopt CCS technology. [78] This is promising given the potential of CCS described in the ISC report, as is the result that 34% of plants responded that they already capture carbon from fermentation for utilization in the food and beverage industry.[79] Another encouraging finding is that 77% of plants surveyed feel they are on target to generate net-zero ethanol by 2050. [80]

The outcomes of the survey emphasize that even without the certification in the proposed amendments, many ethanol plants are already working toward reducing their CI and may have a CI below average.

[72] ISC 2022.
[73] Ibid. p. 30.
[74] Ibid. p. 33.
[75] RFA. 2023. The Energy Transition – How RFA Members Are Driving Progress Toward Net-Zero Carbon Emissions. https://d35t1syewk4d42.cloudfront.net/file/2547/The%20Energy%20Transition%20-%20How%20RFA%20Members%20Drive%20Progress%20-%20June%202023.pdf
[76] RFA. 2023. Progress Toward Net-Zero: Survey of RFA Members. Slideshow presentation. https://d35t1syewk4d42.cloudfront.net/file/2548/Energy%20Transition%20Member%20Survey%20FEW%202023%20-%20Tad%20Hepner.pdf
[77] Ibid. Slide 8.
[78] Ibid. Slide 12.
[79] Ibid. Slide 11.
[80] Ibid. Slide 20.

DATA COLLECTION

In its proposed amendments, CARB does not provide much context on the organizations it expects will certify farms for their sustainability practices. We anticipate that groups such as the International Sustainability & Carbon Certification[81] and the Rainforest Alliance[82] will be selected by farms seeking to pursue certification. In order to complete the applications for these two examples and others, farms will need to gather and submit farm-specific data such as fertilizer use. This fertilizer data would allow CARB to conduct CI scoring for fertilizer use on a farm-by-farm basis, instead of applying an industry average. An approach like this that builds toward farm-by-farm scoring for select elements is a way to incentivize sustainable practices at farms without the time and cost burden of a third-party certification.

We encourage CARB to consider reviewing the data inputs required for applications to various certifying organizations with the purpose of identifying which data requests apply to CARB's goals. CARB can then begin considering these key elements on a farm-by-farm basis, keeping the focus of this activity on specific targets rather than the broad scope often applied by sustainability certification organizations.

PROPOSED CI PENALTY

CARB's proposed amendments seek to assign the CI for ULSD to crop-based biofuel pathways that use uncertified feedstocks.[83] The CI value of ULSD is currently 100.45 gCO_2e/MJ and is set to rise to 105.76 gCO_2e/MJ within the proposed amendments.[84] Earlier in this letter, we reported the primary finding of our Scully et al. 2021 paper, which is that the central estimate CI for corn ethanol is around 51 gCO_2e/MJ.[85] At over double this value, the proposed ULSD CI score of 105.76 gCO_2e/MJ is not reasonably near the central estimate CI for corn ethanol. The value seems particularly arbitrary given that ethanol is a substitute for gasoline, not diesel. Further, CARB's pathway analysis already incorporates a LUC contribution to the CI score, so the proposed amendments would unnecessarily double up on this penalty.

If all ethanol with uncertified corn receives the same 105.76 gCO_2e/MJ score, this takes away incentives for other emissions reduction strategies. For example, an ethanol plant that has incorporated technology/efficiency improvements and has even implemented CCS would be given a CI score that is over double the actual average for corn starch ethanol. Yet, as discussed earlier, CCS has incredible potential to offset substantial emissions from ethanol plants. The

[81] International Sustainability & Carbon Certification. ISCC Certification Schemes. https://www.iscc-system.org/certification/iscc-certification-schemes/

[82] Rainforest Alliance. 2020 Certification Program. https://www.rainforest-alliance.org/for-business/2020-certification-program/

[83] CARB LCFS 2024 Proposed Order. p. 167.

[84] CARB LCFS 2024 Proposed Order. Table 7-1, p. 127.

[85] Scully et al. 2021.

automatic assignment of 105.76 gCO_2e/MJ if feedstock is uncertified may discourage plants from investing in other improvements if these investments will not impact their CI score in California.

CONCLUSION

We thank CARB for the opportunity to comment on the 2024 Proposed Low Carbon Fuel Standard Amendments. Within our letter, we have expressed concern about the feedstock certification requirement. We believe that the complex nature of this amendment's possible impacts requires a level of consideration that has not been presented alongside the proposal.

Our letter walks through a scenario where market impacts caused by a certification requirement could perhaps lead to reduced ethanol content in California's fuels. In sharing recent studies by our team and UCR, we highlight the trend that increasing ethanol content reduces emissions of certain air pollutants, including PM. Ethanol's potential to reduce PM emissions from fuels is critical in the context of the strengthened NAAQS released earlier this month, as EPA projects that California will need to reduce emissions in nearly half of its counties to comply.

Ethanol also presents opportunities to lower GHG emissions from California's fuels, given its CI central estimate of 51 gCO_2e/MJ. We caution that reducing ethanol levels in fuels may work against the GHG reduction goals of CARB. While CARB's proposed amendments would assign the same CI score to crop feedstocks of all types if uncertified, our letter shares research that vegetable oils tend to cause more LUC than starches. The EU incorporates this distinction through policy that focuses on reducing LUC from the highest risk category, a strategy that CARB may wish to consider.

We next describe the encouraging finding that there are multiple viable pathways for ethanol to average net zero by 2050, with CCS identified as a notable strategy to reach emissions reduction targets. Survey results show that many plants have already taken steps toward decarbonization.

Finally, we note that the CI score of 105.76 gCO_2e/MJ that would be assigned to fuels with uncertified feedstocks is unreasonable, as the number is derived for an irrelevant fuel and is more than double the actual CI of corn ethanol.

In summary, we invite CARB to analyze the potential ramifications of a certification requirement for crop feedstocks, keeping in mind the air quality and carbon reduction benefits offered by corn ethanol. We look forward to reviewing a revised version of the 2024 Proposed Low Carbon Fuel Standard Amendments.

Tufts University School of Engineering
Department of Civil and Environmental Engineering

February 3, 2022

Docket Number: EPA-HQ-OAR-2021-0324

Comments of Drs. Fatemeh Kazemiparkouhi,[1] David MacIntosh,[2] Helen Suh[3]
[1] Environmental Health & Engineering, Inc., Newton, MA
[2] Environmental Health & Engineering, Inc., Newton, MA and the Harvard T.H. Chan School of Public Health, Boston, MA
[3] Tufts University, Medford, MA

We are writing to comment on issues raised by the proposed RFS annual rule, the Draft Regulatory Impact Analysis (December 2021; EPA-420-D-21-002), and the supporting Health Effects Docket Memo (September 21, 2021; EPA-HQ-OAR-2021-0324-0124), specifically regarding the impact of ethanol-blended fuels on air quality and public health. We provide evidence of the air quality and public health benefits provided by higher ethanol blends, as shown in our recently published study[1] by Kazemiparkouhi et al. (2021), which characterized emissions from light duty vehicles for market-based fuels. Findings from our study demonstrate ethanol-associated reductions in emissions of primary particulate matter (PM), nitrogen oxides (NOx), carbon monoxide (CO), and to a lesser extent total hydrocarbons (THC). Our results provide further evidence of the potential for ethanol-blended fuels to improve air quality and public health, particularly for environmental justice communities. Below we present RFS-pertinent findings from Kazemiparkouhi et al. (2021), followed by their implications for air quality, health, and environmental justice.

Summary of Kazemiparkouhi et al. (2021)

Our paper is the first large-scale analysis of data from light-duty vehicle emissions studies to examine real-world impacts of ethanol-blended fuels on regulated air pollutant emissions, including PM, NOx, CO, and THC. To do so, we extracted data from a comprehensive set of emissions and market fuel studies conducted in the US. Using these data, we (1) estimated composition of market fuels for different ethanol volumes and (2) developed regression models to estimate the impact of changes in ethanol volumes in market fuels on air pollutant emissions for different engine types and operating conditions. Importantly, our models estimated these changes accounting for not only ethanol volume fraction, but also aromatics volume fraction, 90% volume distillation temperature (T90) and Reid Vapor Pressure (RVP). Further, they did so

[1] https://doi.org/10.1016/j.scitotenv.2021.151426

under both cold start and hot stabilized running conditions and for gasoline-direct injection engines (GDI) and port-fuel injection (PFI) engine types. Key highlights from our paper include:

- ***Aromatic levels in market fuels decreased by approximately 7% by volume for each 10% by volume increase in ethanol content*** (Table 1)**.** Our findings of lower aromatic content with increasing ethanol content is consistent with market fuel studies by EPA and others (Eastern Research Group, 2017, Eastern Research Group, 2020, US EPA, 2017). As discussed in EPA's Fuel Trends Report, for example, ethanol volume in market fuels increased by approximately 9.4% between 2006 and 2016, while aromatics over the same time period were found to drop by 5.7% (US EPA, 2017).

  We note that our estimated market fuel properties differ from those used in the recent US EPA Anti-Backsliding Study (ABS), which examined the impacts of changes in vehicle and engine emissions from ethanol-blended fuels on air quality (US EPA, 2020). Contrary to our study, ABS was based on hypothetical fuels that were intended to satisfy experimental considerations rather than mimic real-world fuels. It did not consider published fuel trends; rather, the ABS used inaccurate fuel property adjustment factors in its modeling, reducing aromatics by only 2% (Table 5.3 of ABS 2020), substantially lower than the reductions found in our paper and in fuel survey data (Kazemiparkouhi et al., 2021, US EPA, 2017). As a result, the ABS's findings and their extension to public health impacts are not generalizable to real world conditions.

Table 1. Estimated market fuel properties

Fuel ID	EtOH Vol (%)	T50 (^oF)	T90 (^oF)	Aromatics Vol (%)	AKI	RVP (psi)
E0	0	219	325	30	87	8.6
E10	10	192	320	22	87	8.6
E15	15	162	316	19	87	8.6
E20	20	165	314	15	87	8.6
E30	30	167	310	8	87	8.6

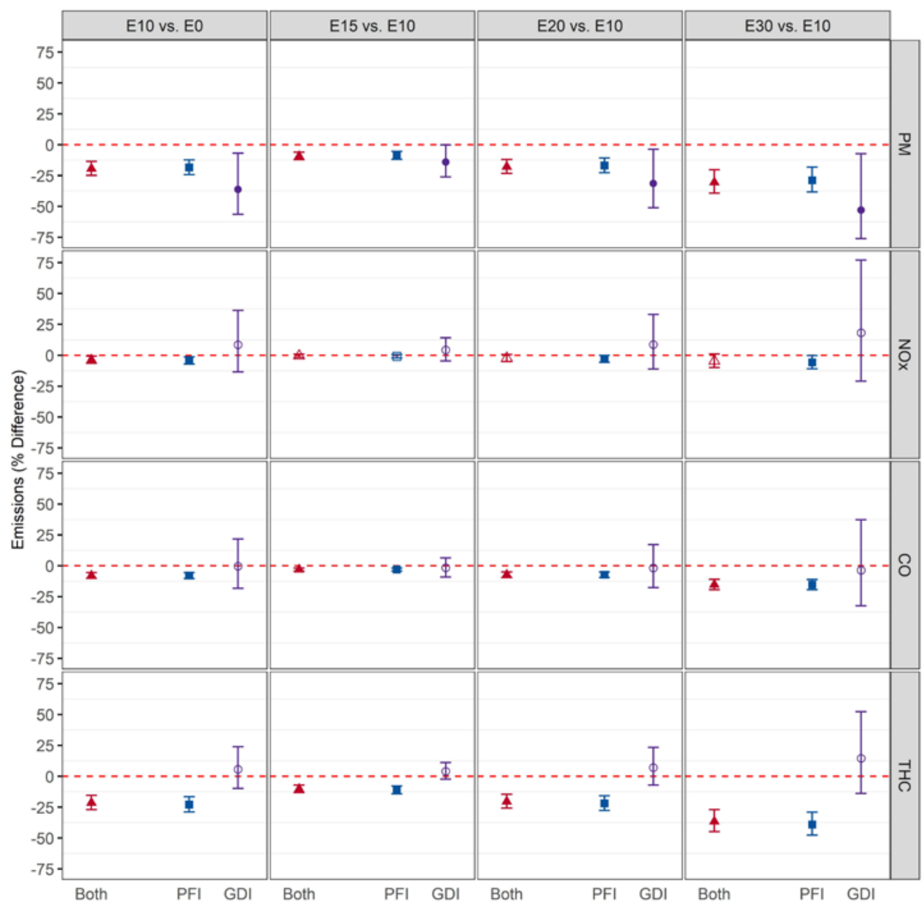
Abbreviations: EtOH = ethanol volume; T50 = 50% volume distillation temperature; T90 = 90% volume distillation temperature; Aromatics=aromatic volume; AKI = Anti-knock Index; RVP = Reid Vapor Pressure.

- ***PM emissions decreased with increasing ethanol content under cold-start conditions.*** Primary PM emissions decreased by 15-19% on average for each 10% increase in ethanol content under cold-start conditions (Figure 1). While statistically significant for both engine types, PM emission reductions were larger for GDI as compared to PFI engines, with 53% and 29% lower PM emissions, respectively, when these engines burned E30 as compared to E10. In contrast, ethanol content in market fuels had no association with PM emissions during hot-running conditions.

  Importantly, our findings are consistent with recent studies that examined the effect of ethanol blending on light duty vehicle PM emissions. Karavalakis et al. (2014), (2015), Yang et al. (2019a), (2019b), Schuchmann and Crawford (2019), for example, assessed the influence of different mid-level ethanol blends – with proper adjustment for aromatics – on the PM emissions from GDI engines and Jimenez and Buckingham (2014) from PFI engines. As in our study, which also adjusted for aromatics, each of these recent studies found higher ethanol blends to emit lower PM as compared to lower or zero ethanol fuels.

Together with these previous studies, our findings support the ability of ethanol-blended fuels to offer important PM emission reduction opportunities. **Cold start PM emissions have consistently been shown to account for a substantial portion of all direct tailpipe PM emissions from motor vehicles**, with data from the EPAct study estimating this portion to equal 42% (Darlington et al., 2016, US EPA, 2013). The cold start contribution to total PM vehicle emissions, together with our findings of emission reductions during cold starts, suggest that a **10% increase in ethanol fuel content from E10 to E20 would reduce total tailpipe PM emissions from motor vehicles by 6-8%.**

Figure 1. Change (%) in cold-start emissions for comparisons of different ethanol-content market fuels[a]



[a] Emissions were predicted from regression models that included ethanol and aromatics volume fraction, T90, and RVP as independent variables

- **NOx, CO and THC emissions were significantly lower for higher ethanol fuels for PFI engines under cold-start conditions**, but showed no association for GDI engines (Figure 1). CO and THC emissions also decreased under hot running conditions for PFI and for CO also for GDI engines (results not shown). [Note that NOx emissions for both PFI and GDI engines were statistically similar for comparisons of all ethanol fuels, as were THC emissions for GDI engines.] These findings add to the scientific evidence demonstrating emission reduction benefits of ethanol fuels for PM and other key motor vehicle-related gaseous pollutants.

Implications for Public Health and Environmental Justice Communities

The estimated reductions in air pollutant emissions, particularly of PM and NOx, indicate that increasing ethanol content offers opportunities to improve air quality and public health. As has been shown in numerous studies, lower PM emissions result in lower ambient PM concentrations and exposures (Kheirbek et al., 2016, Pan et al., 2019), which, in turn, are causally associated with lower risks of total mortality and cardiovascular effects (Laden et al., 2006, Pun et al., 2017, US EPA, 2019, Wang et al., 2020).

The above benefits to air quality and public health associated with higher ethanol fuels may be particularly great for environmental justice (EJ) communities. EJ communities are predominantly located in urban neighborhoods with high traffic density and congestion and are thus exposed to disproportionately higher concentrations of PM emitted from motor vehicle tailpipes (Bell and Ebisu, 2012, Clark et al., 2014, Tian et al., 2013). Further, vehicle trips within urban EJ communities tend to be short in duration and distance, with approximately 50% of all trips in dense urban communities under three miles long (de Nazelle et al., 2010, Reiter and Kockelman, 2016, US DOT, 2010). As a result, a large proportion of urban vehicle trips occur under cold start conditions (de Nazelle et al., 2010), when PM emissions are highest. Given the evidence that ethanol-blended fuels substantially reduce PM, NOx, CO, and THC emissions during cold-start conditions, it follows that ethanol-blended fuels may represent an effective method to reduce PM health risks for EJ communities.

Summary

Findings from Kazemiparkouhi et al. (2021) provide important, new evidence of ethanol-related reductions in vehicular emissions of PM, NOx, CO, and THC based on real-world fuels and cold-start conditions. Given the substantial magnitude of these reductions and their potential to improve air quality and through this public health, our findings warrant careful consideration. Policies that encourage higher concentrations of ethanol in gasoline would provide this additional benefit. These policies are especially needed to protect the health of EJ communities, who experience higher exposures to motor vehicle pollution, likely including emissions from cold starts in particular, and are at greatest risk from their effects.

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California Low Carbon Fuel Standard

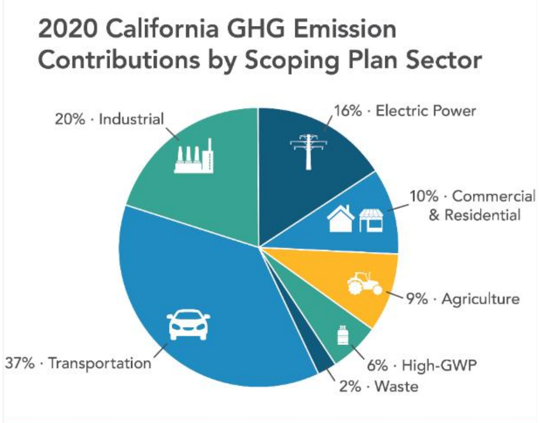
MATTHEW BOTILL
CHIEF, INDUSTRIAL STRATEGIES DIVISION

JANUARY 11, 2024

California's Climate Policy Framework

GHG Targets & Goals

Legislation & Executive Orders: Total GHGs (AB 32/SB 32/AB 1279) or sector targets (SB 1383/SB 100), etc.

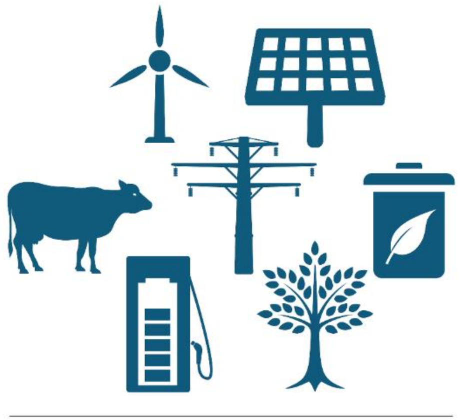


Scoping Plan

Actionable plan across all sectors

Action

Regulations & Incentives: Advanced Clean Cars, climate change investments, etc.



Projects

Examples: Zero-emission trucks, energy infrastructure and renewables, compost facilities, digesters, etc.

The Road
to Zero Emissions

CARB has put a roadmap in place to drastically reduce our dependence on petroleum in the transportation sector by 2045.

AB 32

Requires we cut GHGs.

To reach goals, fuel use must be cut by 94%.

How cuts happen?

Zero emission cars, trucks and fuels.

ACT ACC ACF

CARB rules that make that possible:

Advanced Clean Trucks, Advanced Clean Cars, Advanced Clean Fleets

- ACT: Phases out sale of most fuel-powered trucks by 2035
- ACC: 100% ZEV sales requirement by 2035
- ACF: Requires that trucks in CA be zero emissions by 2045

LCFS

Makes fuel less polluting and encourages production of cleaner alternatives

How it works:

Dirty Fuel	Cleaner Fuel
PAY	EARN

Governor Newsom creates new oversight committee to monitor oil companies

All together, these actions will help us build a cleaner, healthier California for current and future generations.

CARB

Evolution of the LCFS Program - 2009 and 2011 Rulemakings

- First iteration of LCFS adopted in 2009, with revisions in 2011
- Original regulation length: **63 pages**
- First rulemaking established basic framework and included focused on crediting opportunities for the following fuels

Fuel Pathway Crediting

- Renewable Diesel
- Biodiesel
- Ethanol
- Renewable Natural Gas
- Hydrogen
- Electricity

Evolution of the LCFS Program – 2015 Rulemaking

- Cost containment
- Project-based crediting added to recognize emissions reductions in crude oil extraction and refining operations

Fuel Pathway Crediting		Project-based Crediting
• Renewable Diesel • Biodiesel • Ethanol • Renewable Natural Gas • Hydrogen • Electricity	+	• Refinery Investment • Innovative Crude • Renewable Hydrogen for Refineries • Low-Complexity/Low-Energy-Use Refinery

Evolution of the LCFS Program – 2018/2019 Rulemakings

- Compliance targets strengthened/extended to 2030
- Additional crediting opportunities added starting 2019/2020 (ZEV infrastructure, holdback equity spending, third-party verification)

Fuel Pathway Crediting

- Renewable Diesel
- Biodiesel
- Ethanol
- Renewable Natural Gas
- Hydrogen
- Electricity

\+

- Alternative Jet Fuel
- Propane
- Electricity (Incremental crediting and Off-road)

Project-based Crediting

- Refinery Investment
- Innovative Crude
- Renewable Hydrogen for Refineries
- Low-Complexity/Low-Energy-Use Refinery

\+

- Carbon Capture and Sequestration (CCS)

\+

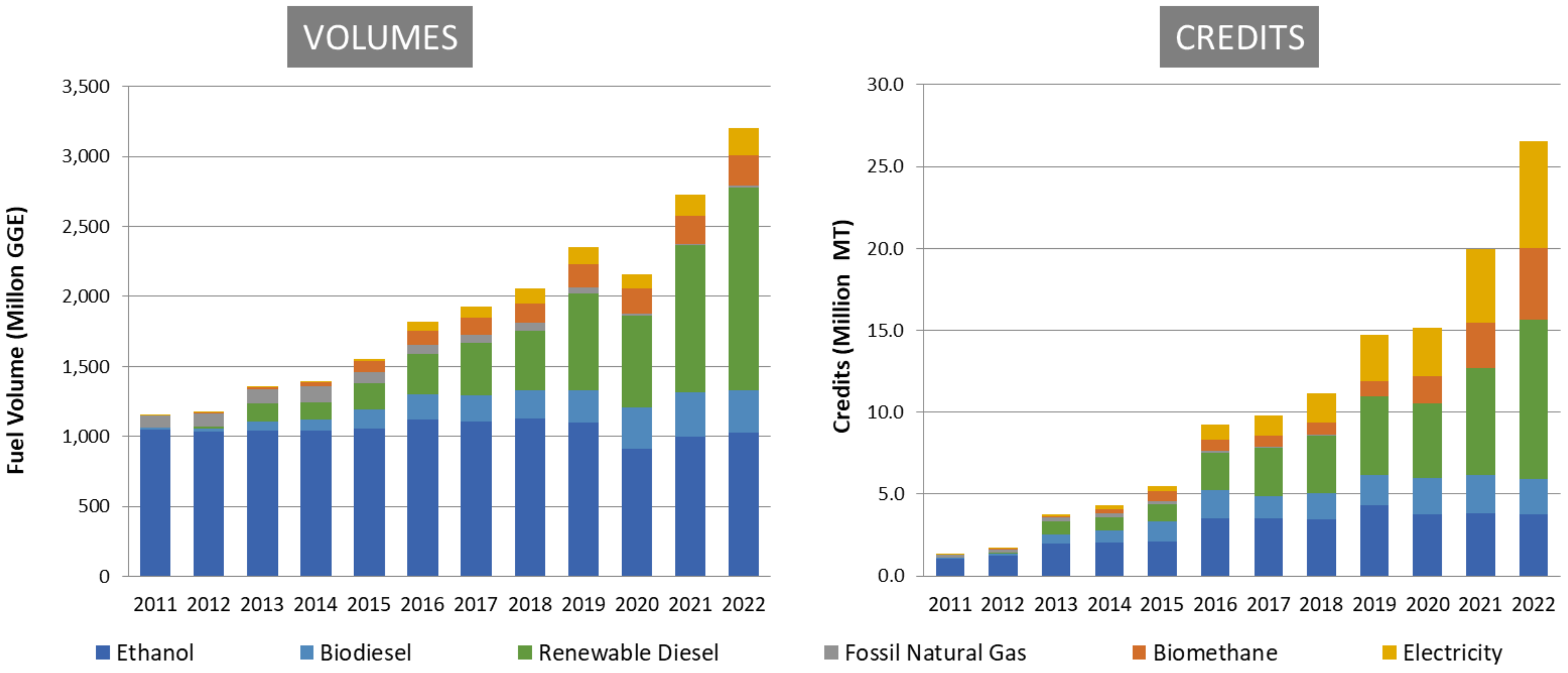
ZEV Infrastructure Crediting

- Hydrogen Refueling Infrastructure (HRI)
- Fast Charging Infrastructure (FCI)

Other Provisions

- Third-party verification
- Holdback equity spending requirements
- Cost containment mechanisms

Growing Alternative Fuel Volumes and Credits



LCFS as an Exportable Policy

- LCFS initiation in CA started with the basic framework and CA successfully created the market structure to incentivize low-carbon fuels.

- Over a decade since initiation, CA LCFS is moving into its next phase

- California has set mid-century carbon neutrality objectives, CA LCFS is being revised to support California climate goals.

- For other jurisdictions: creating the framework and setting initial goals is key to begin moving the market; additional program modifications can follow as needed

California LCFS Regulatory Amendment Proposals

Rulemaking Package Posted

- Initial Statement of Reasons (ISOR) package publicly available on LCFS Rulemaking webpage*
  - Staff Report/ISOR
  - Proposed regulatory text
  - Environmental Impact Analysis
  - Updated Life Cycle Analysis (LCA) modeling tools**
  - Other appendices
- 45-day comment period from Jan 5 – Feb 20, 2024
  - Submit comments through rulemaking docket***

* LCFS Rulemaking Webpage: https://ww2.arb.ca.gov/rulemaking/2024/lcfs2024
** LCA modeling tools: https://ww2.arb.ca.gov/resources/documents/lcfs-life-cycle-analysis-models-and-documentation
*** LCFS Comment Docket: https://www.arb.ca.gov/lispub/comm/iframe_bcsubform.php?listname=lcfs2024&comm_period=A

Robust Public Process

9 PUBLIC WORKSHOPS OVER PAST THREE YEARS

2 COMMUNITY MEETINGS

2 BOARD HEARINGS

OVER 800 COMMENT LETTERS RECEIVED

We Received A Diverse Set of Comments

- Strengthen carbon intensity targets and provide long-term price signals
- Maximize crediting opportunities
- Incentivize development of innovative fuels
- Reduce use of combustion fuels
- Eliminate biomethane from the program
- Continue support for biomethane and prevent stranding assets
- Limit or cap crop-based biofuels
- Expand the use of crop-based biofuel crediting
- Concentrate health and economic benefits in communities burdened by current transportation system
- Provide a mix of low-carbon transportation incentives to communities

Key Concepts for Rulemaking

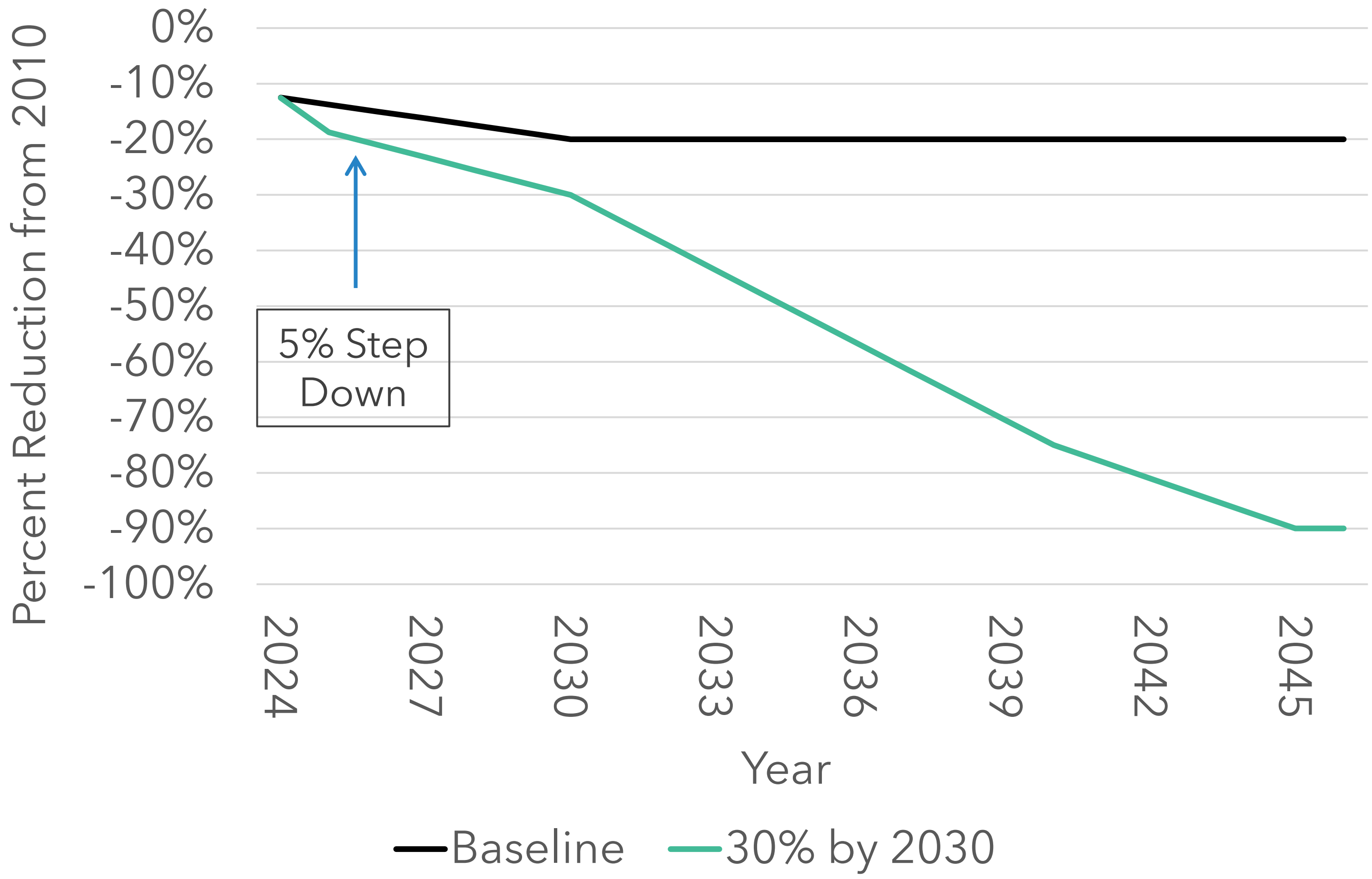
- Increase the stringency of the program to displace fossil fuels
- Strengthen equity provisions to promote investment in disadvantaged, low-income, and rural communities
- Support electric and hydrogen truck refueling
- Increase the use of alternative jet fuel in the State
- Incentivize more production of clean fuels needed in future, such as low-carbon hydrogen
- Support methane emissions reductions and deploy biomethane for best uses across transportation and other sectors
- Consider guardrails on crop-based fuels

Other Considerations

- Light-duty vehicle sector needs
- Federal incentives
- Price-signals for investment
- Air quality benefits
- Transportation costs
- Program administration and streamlining

Strengthen the Annual Carbon Intensity Benchmarks

1. A carbon intensity (CI) reduction of 30% by 2030 and 90% by 2045, compared to 2010 CI baseline
2. A 'step down' in the CI reduction target in 2025 from the current 13.75% to 18.75%



Price Signals for Investment

Table 15: Value Added from LCFS Credit for Low Carbon Fuels under the Proposed Amendments

Fuel	Average CI Value (gCO_2e/ MJ)	2025	2030	2035	2040	2045	Units
*Proposed Amendments Estimated Credit Price**		*$221*	*$76*	*$138*	*$221*	*$105*	$/MT
Corn Ethanol**	55	0.66	0.13	-0.12	-0.77	-0.55	$/gge
Electricity**	64	5.39	1.52	1.54	0.52	-0.37	$/gge
Hydrogen**	-79	7.20	2.25	3.40	4.31	1.38	$/dge
Biodiesel**	40	1.37	0.35	0.28	-0.15	-0.42	$/dge
Renewable Diesel**	44	1.25	0.31	0.20	-0.27	-0.48	$/dge
Landfill NG	45	0.96	0.22	0.08	-0.41	-0.51	$/dge
Dairy NG	-293	11.01	3.68	6.35	9.64	4.26	$/dge

- Modeling 30% by 2030 and 90% by 2045 benchmarks shows increased value of low carbon fuels.
- Auto-Acceleration Mechanism available if program over-performs.

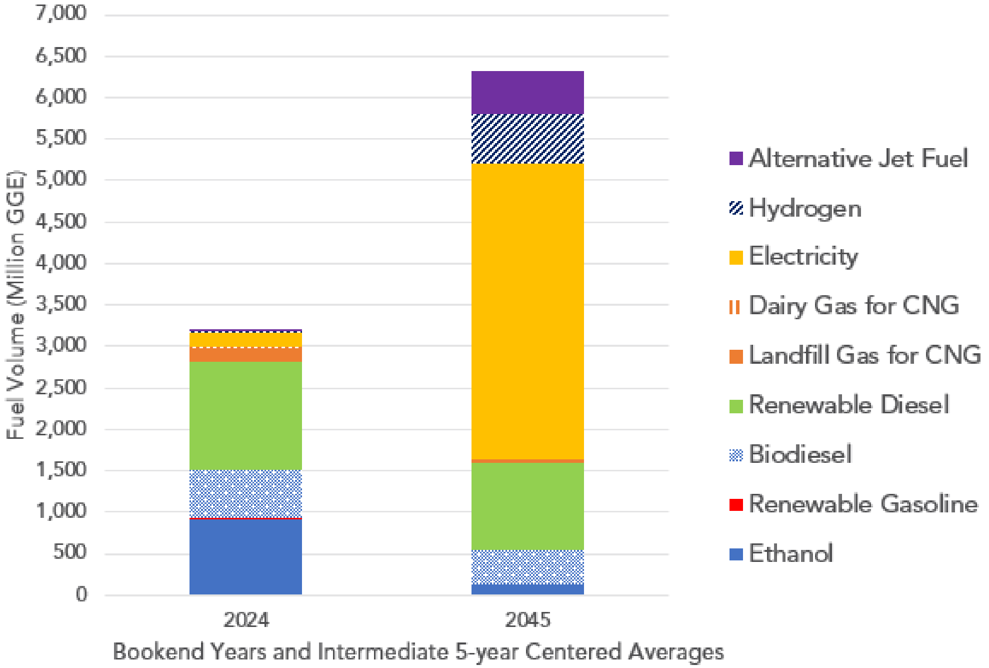
*AAM not modeled in table results

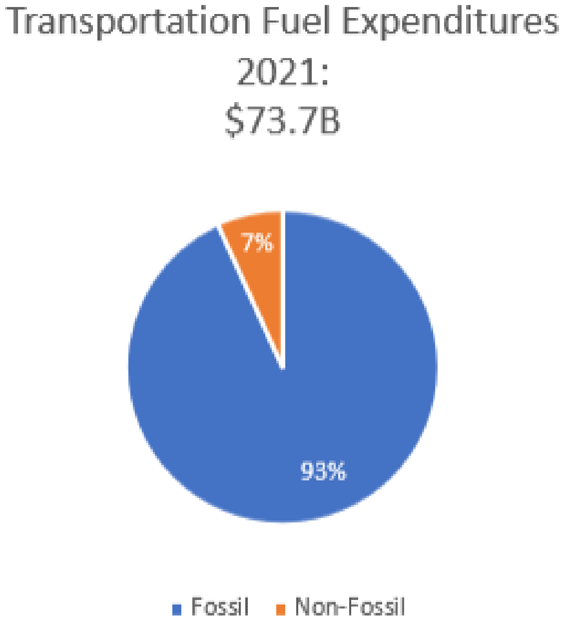
Federal Alignment

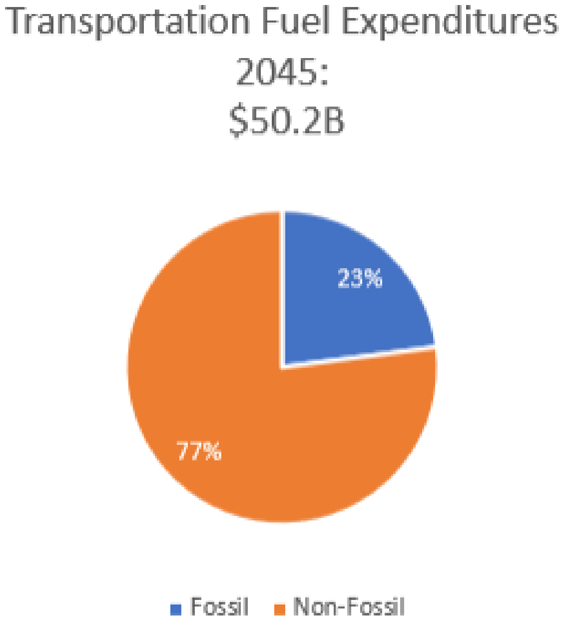
Proposed LCFS Amendments seek to leverage and harmonize with federal investment opportunities

LCFS Proposal	Concurrent Federal Opportunity
Hydrogen book and claim eligibility	Hydrogen producers tax credit (45V)
Regulating fossil jet fuel	SAF producers tax credit (40B) and Federal SAF Grand Challenge
ZEV infrastructure crediting for medium/heavy-duty vehicles	Hydrogen hubs and NEVI charging grants

Transportation Fuel Mix and Costs







Fossil fuel use will continue to decline as low carbon fuels grow

As fossil fuel use is replaced with alternatives CA drivers will save money

Results of AQ/Health Analysis

- Total reduction in criteria pollutant emissions in all air basins from 2024 to 2046
- Total monetized health savings from avoided health outcomes: $5 billion
- Much higher health benefits when tailpipe reductions are included

Other Options Have Drawbacks

- Limits on Decarbonization Options
  - Ending biomethane crediting
  - Limits on biomass diesel
  - No DAC credits

Greater need for fossil diesel, worse health outcomes, more GHG emissions

- More Stringent CI Targets
  - 35% by 2030 with 5% step down in 2025
  - No additional crediting constraints

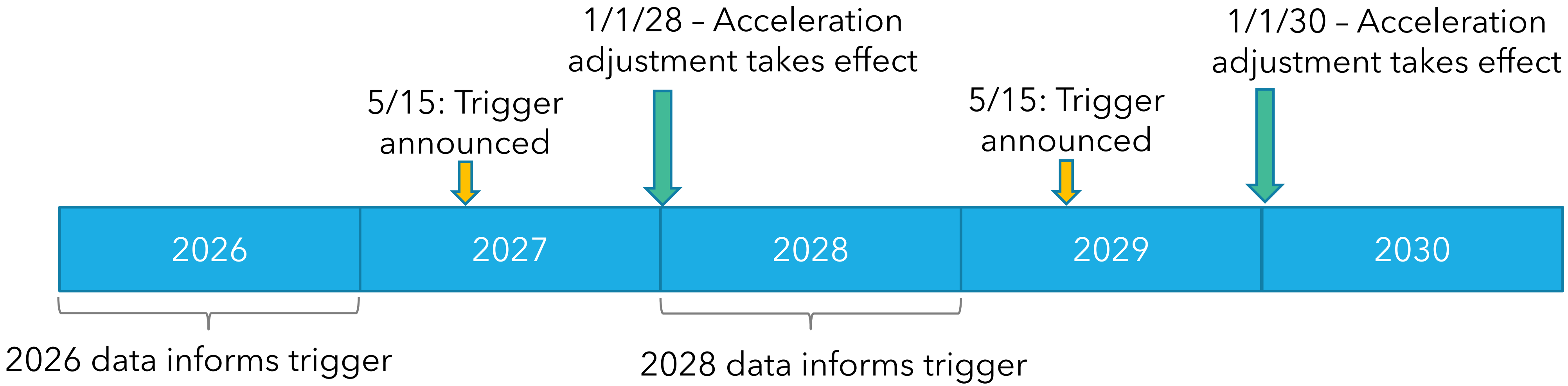
Highest cost scenario

Additional Proposed Regulatory Provisions

- Implement Automatic Acceleration Mechanism
- Eliminate Exemption for Intrastate Fossil Jet Fuel
- Expand Zero Emission Vehicle Infrastructure Crediting
- Apply Biomethane Deliverability Requirements and Phase Out Avoided Methane Pathways
- Add Crop-Based Biofuels Sustainability Criteria
- Improve Equity Provisions

Auto-Acceleration Mechanism

- Advances the upcoming year's CI benchmark, and all subsequent benchmarks by one year, **if triggered**
  - Trigger conditions: annual credit to deficit ratio and credit bank to deficit ratio
  - Can first happen in 2027. If triggered, skips a year.
  - **If triggered in both 2027 and 2029, the 2030 CI benchmark will be the 2032 benchmark (39% CI Reduction)**



Continue and Focus FCI and HRI Crediting

- Propose to extend the light-duty vehicle infrastructure crediting past current end date of 12/31/25
- Also proposing targeted changes to utility-generated holdback credits to accelerate deployment of ZEVs with a focus on equity projects

New Medium- and Heavy-Duty ZEV Infrastructure Crediting

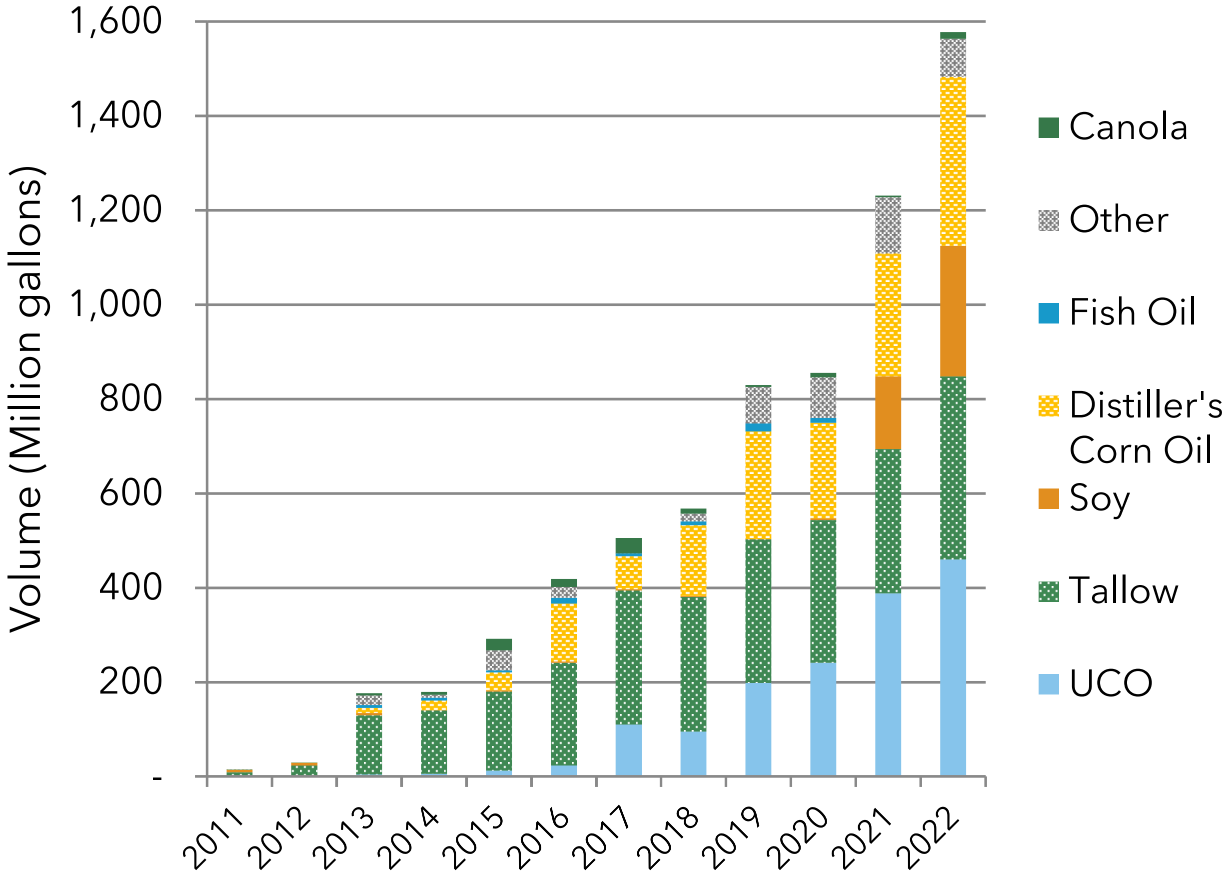
- Refueling infrastructure will be essential to successfully implementing Advanced Clean Fleets (ACF) and Advanced Clean Trucks (ACT)
- Ten years of crediting to support fleet transition to ZEVs, reduce emissions and pollutants in communities heavily impacted by freight travel
- Clean Fuel Reward program to focus on to rebates for new and used medium- and heavy-duty ZE trucks

Biomethane Crediting

- Biomethane supply needs to grow rapidly to support SB 1383 targets and then be deployed to other uses
- 2030 and 2040 are critical milestones for methane reduction and ZEV deployment in California
- Biomethane as a hydrogen feedstock will remain important in LCFS
- Propose continuing biomethane and avoided methane crediting for pathways, with phase out of these pathways if they break ground after 2030

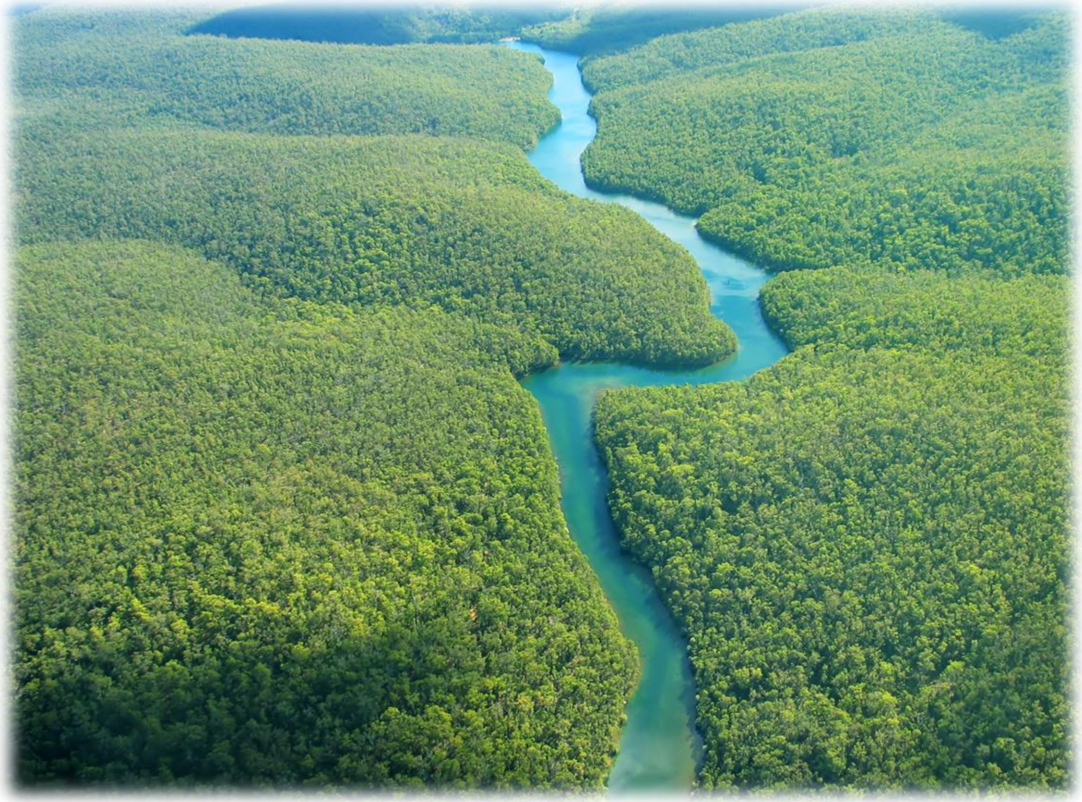
Crop-Based Biofuels Considerations

- Biofuel production must not come at the expense of food production or forests
- Ongoing tracking shows crop-based fuel consumption has historically been steady in the California market but has begun to increase in the last two years
- Other governments have implemented guardrails
- Chair Randolph directed staff to investigate guardrails at the Sept 28, 2023 informational board hearing



Add Crop-Based Biofuels Sustainability Criteria

- Require independent feedstock certification by a certification body approved by the Executive Officer
- Built in a timeline to develop those standards and approval processes by third party certifiers
- Also, propose removing palm-derived fuels from eligibility for credit generation



Streamline Implementation: Pathway Certification

- Credit True-up
  - Mechanism to retroactively provide credits to fuel pathway holders if verified CI is lower than certified CI
- New and updated Tier 1 CI Calculators
  - Broadly applicable to most fuel pathways
  - Will reduce the number of Tier 2 applications
- Verification improvements
  - Clarifying requirements
  - Allowance Option for Less Intensive Verifications

Rulemaking Timeline

January 5, 2024:
45-Day Public Comment Period began

March 21, 2024:
Board consideration and vote on Regulatory Proposal

Late 2024 or early 2025:
LCFS Amendments in Effect

Submit comments into the docket to be considered:

ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard