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March 15, 2023

Liane M. Randolph, Chair
California Air Resources Board
1001 "I" Street
Sacramento, CA 95814

Submitted via CARB's online Comment Submittal Form

Re: Comments on Potential Changes to the Low Carbon Fuel Standard Program.

Dear Chair Randolph and Board Members of the California Air Resources Board:

The Center for Biological Diversity appreciates the opportunity to comment on CARB's proposed changes to the Low Carbon Fuel Standard (LCFS). We offer several concerns and suggestions to improve the program in order to meet the State's climate goals. These include the following:

1) Now that California has banned use of carbon dioxide (CO_2) from carbon capture and storage (CCS) for enhanced oil recovery (EOR) within the state, CARB must remove CCS-related EOR from the LCFS. At present, CARB continues to incentivize EOR out-of-state and assume use of this harmful technology in its modeling.
2) While we support "a phase out crediting of petroleum projects by 2040," we do not support the proposed exclusion of CCS projects. CCS incentivizes and prolongs the use of fossil fuels. Instead, we urge CARB to recognize that allowing fossil fuels plus CCS does not accomplish what is needed to avert worsening the climate crisis and to achieve true emissions reductions.
3) CARB's carbon intensity calculations for fuels made using CCS, such as ethanol with CCS and blue hydrogen, fail to reflect real-world CO_2 capture efficiencies or account for CO_2 and methane emissions across the CCS lifecycle. As a result, CARB significantly underestimates the carbon intensities of fuels made using CCS, and these methodological errors must be corrected.
4) CARB's CA-GREET model currently underestimates the carbon intensity of fuels made with fossil gas and biogas, such as CNG fuels, factory farm gas, and hydrogen, because it relies on assumptions for methane leakage that dramatically underestimate leakage rates and are inconsistent with the best-available science.
5) The current opt-in model for "sustainable aviation fuels" (SAF) is fatally flawed because it allows alternative fuels to be produced using unsustainable and carbon-intensive feedstocks that undermine greenhouse gas reductions and worsen food insecurity. Fully integrating SAFs into the LCFS would only serve to undermine the program's goals and should not be considered.
6) The LCFS must not include pathways for, or otherwise incentivize, transportation fuels made from woody biomass, including electricity, hydrogen, and bio-oil, since these fuels

have high carbon intensities and emit significant amounts of air pollution that harm community health.

These concerns and suggestions are described more fully below.

I. CARB must end LCFS credits to out-of-state projects conducting EOR associated with CCS

Now that California has banned use of carbon dioxide (CO_2) from carbon capture and storage (CCS) for enhanced oil recovery (EOR) within the state, CARB must remove CCS-related EOR from the LCFS. At present, CARB continues to incentivize EOR out-of-state and assume use of this harmful technology in its modeling.

In September 2022, Governor Newsom signed Senate Bill 905 (SB 905) into law.[1] Among other provisions, SB 905 prohibits operators in California from utilizing CO_2 from CCS operations in EOR.[2] It's easy to see why the California Legislature listened to communities in California and banned EOR associated with CCS. EOR involves the injection of fluids and/or gases (such as CO_2) underground to extract fossil fuels.[3] EOR threatens drinking water integrity, yet regulations on EOR activities are decades old and fall short of providing sufficient safeguards for groundwater.[4] In addition, all forms of EOR have some risk of blowouts that can result in leakage and/or surfacing of fossil fuels or injection fluids.[5] And throughout the EOR lifecycle—from construction to injection, production, and waste disposal—there are risks to the environment and communities from air, water, and noise pollution.[6] Adding to this is the contribution to climate change caused by extracting and using more fossil fuels via EOR. One study found that for each ton of CO_2 injected for EOR, 2.7 tons of CO_2 are eventually emitted from burning recovered oil.[7]

Yet while California decidedly took a stand against CCS-associated EOR within the State, CARB's LCFS door remains open to incentivizing this same harmful practice *outside* the State's borders. Under the LCFS CCS Protocol, applicable CCS projects are those "that capture carbon dioxide and sequester it onshore, in either saline or depleted oil and gas reservoirs, *or oil and gas reservoirs used for CO_2-enhanced oil recovery (CO_2- EOR)*.[8] Thus, non-California

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[1] S.B. 905, 2021-2022 Regular Session (Cal. 2022), https://leginfo.legislature.ca.gov/faces/billStatusClient.xhtml?bill_id=202120220SB905.
[2] *Id.* at Section 4(b), to be codified in Cal. Pub. Res. § 3132(b); *see also* S.B. 1314, 2021-2022 Regular Session (Cal 2022) (also signed into law and prohibiting EOR using CO_2 derived from CCS operations).
[3] Clean Water Action, The Environmental Risks and Oversight of Enhanced Oil Recovery in the United States at 5 (2017), https://www.cleanwater.org/sites/default/files/docs/publications/The%20Environmental%20Risks%20and%20Oversight%20of%20Enhanced%20Oil%20Recovery%20in%20the%20United%20States.pdf (CWA EOR Report).
[4] *Id.*
[5] *Id.* at 13.
[6] *Id.* at 12.
[7] *Id.* at 23, citing Banks, Brian et al., SaskPower's Carbon Capture Project – What Risks? What Rewards?, Canadian Center for Policy Alternatives at 16-17 (2015) (noting that this calculation "does not even account for carbon dioxide losses in the course of the injection process: a substantial proportion returns to the surface with the oil.").
[8] CARB, Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard at 7 (Aug. 13, 2018) (emphasis added). CCS projects are eligible for LCFS participation under the Tier 2 pathway. *See* 17 Cal. Code Regs. § 95488.1(d)(7)(B).

regulated entities conducting EOR will be compensated by CARB for causing environmental and community health damage elsewhere. This asymmetry is simply wrong and must be corrected by removal of CCS-related EOR from the LCFS.

Our suggested changes to remove CCS-related EOR are as follows:

1) CARB must remove the bolded language below from the LCFS CCS Protocol:
    - The CCS Protocol applies to projects "that capture carbon dioxide (CO_2) and sequester it onshore, in either saline or depleted oil and gas reservoirs, **or oil and gas reservoirs used for CO_2-enhanced oil recovery (CO_2- EOR)."**
2) CARB must update its regulations with the following changes:
    - In 17 Cal. Code Regs. section 95490(a)(1) (stating that eligible entities include "Alternative fuel producers, refineries, and oil and gas producers that capture CO_2 on-site and geologically sequester CO_2 either on-site or off-site"), make clear that, to be eligible, capture and sequestration of CO_2 does not include EOR.
    - In 17 Cal. Code Regs. section 95490(a)(2) (stating that "If CO_2 derived from direct air capture is converted to fuels, it is not eligible for project-based CCS credits. However, applicants may apply for fuel pathway certification using the Tier 2 pathway application process as described in section 95488.7."), make clear that CO_2 derived from direct air capture may not be used for EOR.

Finally, CARB must eliminate any modeling assumptions incorporating use of CCS-related EOR. For example, the November 2022 technical documentation accompanying the CATS model assumes "that the majority of CO_2 captured from ethanol would either be *used* or stored in oil and gas fields."[9] The "use" assumed in this modeling could include EOR. As explained above, because California banned CCS-related EOR, CARB must not assume (or incentivize) its use elsewhere.

II. CARB Must Not Allow CCS to Extend the Life of Fossil Fuels in the LCFS

In draft section 95489, Provisions for Petroleum-Based Fuels, CARB notes that staff is considering "a phase out crediting of petroleum projects by 2040, with carbon capture and sequestration projects excluded."[10] While we support a rapid phasing out credits to fossil fuels, we urge CARB to recognize that allowing fossil fuels plus CCS does not accomplish what is needed to avert worsening the climate crisis and to achieve true emissions reductions.

In modeling, there is often an assumption that CCS will achieve a carbon capture rate as high as 90%. This both wildly overshoots what typically occurs with real-world CCS deployment (see below) and means that—even if those models are true—fossil fuel infrastructure would be credited under the LCFS while still emitting harmful GHGs and other pollutants. As the Institute for Energy Economics and Financial Analysis (IEEFA) explained, "The 90% emission reduction target generally claimed by the industry has been unreachable in practice."[11] In its study, IEEFA examined CCS projects in the natural gas, industrial and power sectors.[12] CCS used in the power

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[9] CARB, Draft - California Transportation Supply Model Documentation at 20 (Nov. 2022) (emphasis added).
[10] CARB, Preliminary Draft of Potential Regulatory Amendments and Amendment Concepts at 30.
[11] IEEFA, Carbon capture remains a risky investment for achieving decarbonization (Sept. 2, 2022), https://ieefa.org/resources/carbon-capture-remains-risky-investment-achieving-decarbonisation.
[12] *Id.*

section had the worst results, and across the board CCS projects showed that CCS continues to overpromise and underperform.[13]

Performance of CCS on fossil fuel infrastructure shows that the technology regularly over-promises and under-delivers on carbon capture targets. For example, in 2021, Chevron admitted that its self-described "world's biggest CCUS project," the Gorgon natural gas-fired powerplant in Australia, failed to meet its five-year capture target of 80%, instead reaching only around 30%.[14] Similarly, while the Petra Nova coal-fired power plant in Texas promised to capture 90% of its GHG emissions, it achieved only a 65-75% capture rate, which reduced further to 50% when the fossil fuels needed to capture and store the carbon were taken into account.[15] And ExxonMobil's Shute Creek natural gas-fired power plant in Wyoming failed its capture targets by 34%, venting the rest of its carbon emissions into the atmosphere.[16] Further, research shows that once the social cost of carbon capture is taken into account—in other words, the resulting air pollution, potential health problems, economic costs and overall contributions to climate change—the impacts of CCS are similar to or higher than a fossil fuel plant without carbon capture.[17]

III. CARB Must Revise Its Flawed Methodologies for Calculating the Carbon Intensities of Fuels Made with CCS Which Underestimate Their True Climate Impacts.

CARB's carbon intensity calculations for fuels made using CCS, such as ethanol with CCS and blue hydrogen, fail to reflect real-world CO_2 capture efficiencies or account for CO_2 and methane emissions across the CCS lifecycle. As a result, CARB significantly underestimates the carbon intensities of fuels made using CCS, and these methodological errors must be corrected.

A. CARB's assumption of 80 to 90 percent CO_2 capture efficiencies does not reflect the real-world performance of CCS projects.

CARB assumes an 80 to 90% capture efficiency for CO_2 in CCS projects.[18] However, as described above, real-world examples show that CCS projects have consistently over-promised and vastly under-performed on capturing CO_2 emissions. CARB's modeling that ignores the

[13] *Id.* (noting "Close to 90% of proposed CCS capacity in the power sector has failed at implementation stage or was suspended early . . . . Further, most projects have failed to operate at their theoretically designed capturing rates.").
[14] *See* Readfearn, Graham, *Australia's only working carbon capture and storage project fails to meet target*, The Guardian, Nov. 11, 2021, https://www.theguardian.com/australia-news/2021/nov/12/australias-only-working-carbon-capture-and-storage-project-fails-to-meet-target; Milne, Peter, *Chevron's five years of Gorgon carbon storage failure could cost $230 million*, Sydney Morning Herald, Nov. 11, 2021, https://www.smh.com.au/environment/climate-change/chevron-s-five-years-of-gorgon-carbon-storage-failure-could-cost-230-million-20211110-p597uf.html.
[15] IEEFA, Reality of carbon capture not even close to proponents' wishful thinking (Aug. 8, 2019), https://ieefa.org/resources/ieefa-op-ed-reality-carbon-capture-not-even-close-proponents-wishful-thinking.
[16] IEEFA, Carbon capture to serve enhanced oil recovery: Overpromise and underperformance (March 1, 2022), https://ieefa.org/resources/carbon-capture-serve-enhanced-oil-recovery-overpromise-and-underperformance.
[17] *Id.*; *see also* IEEFA, Carbon Capture and Storage Is About Reputation, Not Economics at 4 (2020), https://ieefa.org/wp-content/uploads/2020/07/CCS-Is-About-Reputation-Not-Economics_July-2020.pdf (noting that he energy required to capture, transport, and inject carbon underground "materially reduces its net benefit.").
[18] CARB, Draft - California Transportation Supply Model Documentation (Nov. 2022) at 18. CARB cites a single report for this premise, and it is unclear how CARB derived the capture efficiency estimates from this report.

consistent underperformance of CCS projects and assumes that CCS equipment will operate according to idealized specifications ignores the reality of chronic malfunctions, flaring and venting, and shutdowns that substantially increase emissions in practice. By assuming unfounded CO_2 capture efficiency rates, CARB is underestimating the carbon intensity of fuels made using CCS.

B. CARB must account for CO_2 emissions across the CCS lifecycle for fuels made using CCS.

CARB does not appear to be accounting for the CO_2 emissions across the CCS lifecycle for fuels made using CCS, including the substantial CO_2 emissions from the CCS energy penalty. CCS operations are energy-intensive because they require large amounts of energy to capture, compress, transport, and inject carbon underground, called the "energy penalty." For example, power plants using CCS consume an estimated 15% to 25% more energy to produce the same amount of power than a conventional plant.[19] These energy "penalties" mean that CCS projects emit significant additional CO_2 emissions from burning the fuel to run the CCS equipment as well as the upstream emissions from the extraction, processing, and transport of that fuel.[20] For example, at the Petra Nova coal-fired power plant, the carbon capture equipment covered the coal boiler but not the gas turbine used to power the CCS equipment. When the emissions from the gas turbine were taken into account, the CCS equipment captured only 34% of coal plus gas combustion CO_2 emissions.[21] Furthermore, when the upstream emissions from the extraction and processing of coal used in the boiler and fossil gas used to run the CCS equipment were taken into account, the CCS equipment reduced the coal and gas combustion plus upstream CO_2 a net of only 10.8% over 20 years and 20% over 100 years.[22] The study concluded that when lifecycle CCS emissions are taken into account, CCS "reduces only a small fraction of carbon emissions."[23]

In addition to CO_2 emissions associated with the energy penalty at the industrial facility, CARB must evaluate the other sources of CO_2 emissions across the CCS lifecycle, including the emissions associated with CO_2 transport and injection. CO_2 transport by trucks, rail or barge can significantly increase CO_2 emissions, especially when there are large distances between industrial facilities which are spread across the state, and injection sites which are targeted for the Central Valley. CO_2 transport by pipeline also poses significant CO_2 emissions risks due to inevitable pipeline leaks and blow-outs. At the site of injection, the energy needed to pump CO_2 underground for storage and other purposes has associated CO_2 emissions. CO_2 that is stored underground risks leakage back to the atmosphere, based on the long track record of fossil fuel industry leaks and spills.[24]

[19] Climate Action Network Int'l, CAN Position: Carbon Capture, Storage, and Utilisation at 9 (2021), https://climatenetwork.org/resource/can-position-carbon-capture-storage-and-utilisation/.
[20] *Id.*
[21] Jacobson, Mark Z, The health and climate impacts of carbon capture and direct air capture, 12 Energy Environ. Sci 3567 (2019).
[22] *Id.*
[23] *Id.*
[24] Conley. S. et al., Methane emissions from the 2015 Aliso Canyon blowout in Los Angeles, CA, 351 Science 1317 (2016), https://science.sciencemag.org/content/351/6279/1317.

C. CARB must account for methane leakage in its carbon intensity calculations for blue hydrogen.

In its calculations for the carbon intensity of blue hydrogen, CARB must account for the inevitable methane leakage from the production, processing, and transport of fossil gas used to produce the hydrogen and run the CCS equipment. A Cornell study that evaluated the lifecycle emissions of blue hydrogen, accounting for emissions of both CO_2 and unburned fugitive methane, concluded that the greenhouse gas emissions from the production of blue hydrogen are very high, at only 9%-12% less than for gray hydrogen made without CCS.[25] This is because the methane leakage emissions for blue hydrogen are higher than for gray hydrogen due to the increased use of fossil gas to power the CCS equipment. An analysis by the Natural Resources Defense Council found that "upstream leakage at average rates reported in the United States would add another 2.1 CO_2 per kg H_2 to the carbon intensity of blue hydrogen — roughly double the onsite emissions for SMR with 90% carbon capture."[26] At present, CARB is underestimating the carbon intensity of blue hydrogen by failing to factor in methane leakage.

IV. CARB Must Update the CA-GREET Model with Accurate Assumptions for Methane Leakage for Fuels Made with Fossil Gas and Biogas.

The CA-GREET model currently underestimates the carbon intensity of fuels made with fossil gas and biogas, such as CNG fuels, factory farm gas, and hydrogen, because it relies on assumptions for methane leakage that dramatically underestimate leakage rates and are inconsistent with the best-available science. The CA-GREET model assumes that the upstream leakage rate for conventional natural gas is 1.14% and the leakage rate for shale gas is 1.21%.[27] These are considerable underestimates at odds with the best-available science on methane leakage from gas production, handling, and transportation. The majority of scientific literature estimates average U.S. methane leakage rates at 1.6 times to more than two times the rates used in the CA-GREET model.[28]

Making the situation worse, fossil gas produced in California has a methane leakage rate that is much higher than the U.S. average, making CARB's estimates even more out of step. A recent analysis found that the methane leakage rate for gas sourced from the San Joaquin Valley is 4.8%,[29] making this gas not only worse than coal in terms of its carbon intensity but also the worst leakage rate in the continental United States. The fossil gas consumed in California has an

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[25] Howarth, Robert W. & Mark Z. Jacobson, How green is blue hydrogen?, 9 Energy Sci. and Engineering 1676 (2021), https://doi.org/10.1002/ese3.956.

[26] Earthjustice, Reclaiming Hydrogen for a Renewable Future (2021), https://earthjustice.org/sites/default/files/files/hydrogen_earthjustice_2021.pdf.

[27] CARB, CA-GREET3.0 Lookup Table Pathways Technical Support Documentation, at 20, Table C.2. (Aug. 13, 2018), https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/ca-greet/lut-doc.pdf?_ga=2.244773765.1612320332.1659372127-1168559359.1580157486.

[28] Alvarez, Ramon A. et al., Assessment of methane emissions from the U.S. oil and gas supply chain, 361 Science 186 (2018); Howarth & Jacobson (2021)..

[29] Burns, Diana & Emily Grubert, Attribution of production-stage methane emissions to assess spatial variability in the climate intensity of US natural gas consumption, 16 Envtl. Research Letters 4 (2021), https://doi.org/10.1088/1748-9326/abef33.

overall leakage rate of 2.8%,[30] which is also much higher than the leakage rates used in the CA-GREET model.

CARB must also account for the leakage of factory farm gas during all stages of production, transport, and refining. For example, a study of methane leakage from biogas plants found that leaked methane can be as high as 14.9% of total methane production.[31] Importantly, one recent study concluded that renewable natural gas from intentionally produced methane—as is the case with factory farm methane—is always a net greenhouse gas emitter unless total system leakage is zero.[32]

Methane is a super-pollutant more than 80 times more powerful than CO_2 at warming the atmosphere over a 20-year period,[33] second only to CO_2 in driving climate change.[34] Recognizing this, a recent report by the United Nations Environment Program concluded that "methane emissions globally from all sources need to be reduced by 40%-45% by 2030 in order to achieve the least cost pathway for limiting the increase in the Earth's temperature to 1.5°C."[35] Therefore, it is imperative that CARB properly factor methane leakage into the carbon intensity of fuels made with fossil gas and biogas, so as not to unfairly incentivize these polluting fuels.

V. "Sustainable" Aviation Fuels and Forest Biomass Should Not Be Fully Integrated Into the LCFS.

A. "Sustainable" Aviation Fuels should not be fully integrated into the LCFS.

Aviation fuel is eligible under the Low Carbon Fuel Standard as an opt-in fuel and is currently being considered for full integration into the program. Given the inherent failures of aviation as an opt-in at present, there is neither an environmental nor a greenhouse gas emissions benefit to bringing aviation fully under the LCFS program. Aviation fuel's current track record in the LCFS program instead points to the failures of the program as whole.

The current opt-in model is fatally flawed because it allows alternative fuels to be produced using unsustainable and carbon-intensive feedstocks. Currently refiners are not required to reduce the carbon intensity of conventional jet fuel, but alternative aviation fuel producers can generate and sell LCFS credits for revenue. This is highly problematic because the LCFS does not preclude the use of unsustainable and environmentally harmful feedstocks in producing these alternative fuels. The most blatant example of this is the allowance for crop-

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30 *Id.*

31 Scheutz, Charlotte & Anders M. Fredenslund, Total methane emission rates and losses from 23 gas plants, 97 Waste Mgmt. 38-46 (2019), https://doi.org/10.1016/j.wasman.2019.07.029.

32 Grubert, Emily, At scale, renewable natural gas systems could be climate intensive: the influence of methane feedstock and leakage rates, 15 Envtl. Research Letters 8 (2020), https://iopscience.iop.org/article/10.1088/1748-9326/ab9335.

33 Forster, P. et al., The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity: In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (2021), doi:10.1017/9781009157896.009, at Table 7.15.

34 United Nations Environment Programme & Climate and Clean Air Coalition, Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions (2021) at 11, https://www.unep.org/resources/report/global-methane-assessment-benefits-and-costs-mitigating-methane-emissions.

35 *Id.*

based feedstocks. As noted in recent documentation from the Air Resources Board,[36] the use of crop-based oils to produce biofuels has only increased over time in California with large investments made to secure additional crop-based feedstock. Yet fuels derived from crop-based feedstocks are known to have exceptionally high lifecycle greenhouse gas emissions, on par with fossil fuels, setting up a direct contradiction to the low-carbon fuel goal.[37] In diverting crops from food to fuel production, new land is often cleared to replace that lost food supply, which results in indirect land use change emissions. These indirect emissions undermine any greenhouse gas savings from crop-derived alternative fuels.[38]

Moreover, the diversion of crops to biofuels and the resulting decline in food supply has been shown to lead to increased food prices, worsening global food insecurity. The need to replace those diverted crops also means the consumption of additional resources such as water and the use of more fertilizers and pesticides that contribute to runoff.[39] Thus, reliance on crops for biofuels leads to more crop cultivation, which in turn can contribute both to water scarcity and the contamination of surface and ground water resources.[40]

Yet California seems fully poised to embrace such problematic feedstocks, as evidenced by numerous refinery conversion efforts statewide. One such conversion project is the Martinez Refinery Renewable Fuels Project in Contra Costa County.[41] This project is expected to produce fuels such as renewable diesel, propane, naphtha, and aviation fuels with crop-based feedstocks like distillers corn oil and virgin soybean oil. Despite numerous comments on this project pointing to the dangers of using crop-based feedstocks,[42] the project uses the LCFS as justification of its implementation. The same justification was used for the Phillips 66 Rodeo Renewed Project,[43] a refinery conversion project also in Contra Costa County, and the AltAir

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[36] CARB, Low Carbon Fuel Standard Public Workshop: Potential Regulation Amendment Concepts (February 22, 2023), https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/lcfs_meetings/LCFSpresentation_02222023.pdf.

[37] Zhao, Xin et al., Estimating induced land use change emissions for sustainable aviation biofuel pathways, 779 Science and the Total Environment (2021).

[38] Pavlenko, Nikita & Searle, S., Fueling Flight: Assessing the sustainability implications of alternative aviation fuels, International Council on Clean Transportation (2021); Zhao, X. et al., Estimating induced land use change emissions for sustainable aviation biofuel pathways, 779 Science and the Total Environment (2021).

[39] Gerbens-Leenes, P.W., Bioenergy water footprints, comparing first, second and third generation feedstocks for bioenergy supply in 2040, 59 Europen Water 373 (2017); National Research Council, Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy (2011); Rulli, Maria Christina et al., The water-land-food nexus of first-generation biofuels, 6 Nature Scientific Reports (2016).

[40] Fleming, J., The Biofuels Myth: Why 'Sustainable Aviation Fuels' Won't Power Climate-Safe Air Travel (August 2022), Center for Biological Diversity, https://biologicaldiversity.org/programs/climate_law_institute/pdfs/2022_The_Biofuels_Myth_Center_for_Biological_Diversity.pdf.

[41] Martinez Refinery Renewable Fuels Project Draft Environmental Impact Report (October 2021), https://www.contracosta.ca.gov/DocumentCenter/View/72957/Martinez-Refinery-Renewable-Fuels-DEIR-Vol-1-Complete-DEIR.

[42] Martinez Refinery Renewable Fuels Project Final Environmental Impact Report (March 2022), https://www.contracosta.ca.gov/DocumentCenter/View/74460/Martinez-Refinery-Renewable-Fuels-Project-FEIR.

[43] Rodeo Renewed Project Draft Environmental Impact Report (October 2021), https://www.contracosta.ca.gov/DocumentCenter/View/72880/Rodeo-Renewed-Project-DEIR-October-2021-PDF.

Renewable Fuels Conversion Project in Los Angeles County.[44] The intent of the latter is to in part provide alternative aviation fuels while using feedstocks such as virgin vegetable oils, all while purportedly meeting the requirements of the LCFS.

The LCFS is ineffective at present because it allows deleterious feedstocks and expanding the program to include aviation fuels will not even address most of the emissions from the aviation sector. A recent analysis by the International Council on Clean Transportation found that, even if feedstocks were not an issue, the LCFS would still be ineffective due to its faulty credit and deficit system. According to the analysis, expanding the coverage of the LCFS to aviation fuels consumed for intrastate flights would do little to dissuade the use of conventional jet fuels because of the overabundance of credits in the system that could be used to make up for shortfalls in aviation emissions fuel reductions.[45] Therefore, with both the feedstock and credit issues, there is virtually no benefit to fully folding aviation and alternative jet fuels into the LCFS. Instead, the program needs a full overhaul where fuels must meet stringent criteria for sustainability, and bad actors are unable to buy their way out of true emissions reductions with surplus credits.

B. The LCFS should not include future pathways for forest biomass as a "low-carbon" source of electricity, hydrogen, or other fuels.

The LCFS must not include pathways for, or otherwise incentivize, transportation fuels made from woody biomass, including electricity, hydrogen, and bio-oil, since these fuels have high carbon intensities and emit significant amounts of air pollution that harm community health.

Producing electricity, hydrogen and bio-oil from woody biomass feedstocks emits significant *upstream emissions* from cutting trees, extracting cut materials, trucking biomass often long distances in diesel trucks, drying and chipping the wood, and wood chip storage which releases significant methane emissions.[46] The combustion, gasification, or pyrolysis of woody biomass releases all the wood's stored carbon to the atmosphere, resulting in enormous *downstream emissions*, all while reducing the capacity of cut forests to store and sequester carbon.[47] It is well-established that combusting woody biomass to generate electricity emits more CO_2 per unit of energy produced than fossil fuels, including coal.[48] Biomass energy produces emissions at the smokestack in the range of 3,220 pounds CO_2/MWh, which significantly exceed

[44] AltAir Renewable Fuels Conversion Project Draft Susbsequent Environmental Impact Report (December 2021), https://files.ceqanet.opr.ca.gov/262390-3/attachment/QEtyt4vQVeyeIUgpinWLuW1pxnoOvxRF7Q81Pp1-SjrBmAXUaB4WCafVuHaRALoB1r_1EKn0AoA3LMp70.

[45] O'Malley, Jane, Will California Rise to the Biden Administration's SAF Grand Challenge? (Jan. 25, 2023), https://theicct.org/ca-sustainable-aviation-fuels-jan23/.

[46] See, for example, upstream emissions estimates in Roder, Mirjam et al., How certain are greenhouse gas reductions from bioenergy? Life cycle assessment and uncertainty analysis of wood pellet-to-electricity supply chains from forest residues, 79 Biomass and Bioenergy 50 (2015), 10.1016/j.biombioe.2015.03.030.

[47] *Id.*

[48] Sterman, John et al., Does wood bioenergy help or harm the climate?, 78 Bulletin of the Atomic Scientists 128 (2022), DOI:10.1080/00963402.2022.2062933.

emissions from coal and fossil gas.[49] Smaller-scale biomass power plants using gasification technology are similarly carbon-intensive.[50]

Despite the substantial carbon pollution from biomass power, proponents erroneously claim that cutting and incinerating trees is inherently "carbon neutral"—that it does not cause net GHG emissions.[51] Published scientific research has thoroughly debunked this false claim. As a result, the IPCC, federal Environmental Protection Agency's Science Advisory Board, and numerous other scientific bodies have established that woody biomass energy should not be assumed carbon neutral.[52] Cutting and burning trees for energy releases their stored carbon to the atmosphere, immediately increasing CO_2 emissions and ending trees' future carbon sequestration, creating a "carbon debt."[53] To claim biomass energy is carbon neutral, biomass proponents try to discount the released carbon by taking credit for the carbon that will be absorbed by future tree growth—claiming the carbon debt will eventually be repaid. This is misleading because forest regrowth takes time and is highly uncertain—there is no guarantee that cut forests will be allowed to grow back or that forests won't be converted to other land uses. Once trees are cut, numerous studies show it may take many decades to more than a century, if ever, to pay back the carbon that was lost from cutting and incinerating them.[54]

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[49] Manomet Ctr. for Conservation Scis., Massachusetts Biomass Sustainability and Carbon Policy Study: Report to the Commonwealth of Massachusetts Department of Energy Resources (2010) at 103, https://www.mass.gov/doc/manometbiomassreportfullhirezpdf/download.

[50] For example, the Cabin Creek bioenergy project approved by Placer County would have an emissions rate of more than 3,300 lbs CO_2/MWh. *See* Ascent Environmental, Cabin Creek Biomass Facility Project Draft Environmental Impact Report, App. D (July 27, 2012) (describing 2 MW gasification plant with estimated combustion emissions of 26,526 tonnes CO_2e per year and generating 17,520 MWh per year of electricity, resulting in emissions of 3,338 lbs CO_2e per MWh).

[51] *Id.*

[52] IPCC, *Frequently Asked Questions*, *Intergovernmental Panel on Climate Change (IPCC) Task Force on National Greenhouse Gas Inventories*, http://www.ipcc-nggip.iges.or.jp/faq/faq.html (last visited Nov. 10, 2022) at Q2-10 ("The IPCC Guidelines do not automatically consider biomass used for energy as 'carbon neutral,' even if the biomass is thought to be produced sustainably); Honeycutt, Michael, Letter from Michael Honeycutt, U.S. EPA Sci. Advisory Bd., to Andrew Wheeler, U.S. EPA Administrator, SAB Review of Framework for Assessing Biogenic CO2 Emissions from Stationary Sources (Mar. 5, 2019), https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=539269&Lab=OAP at 2 ("not all biogenic emissions are carbon neutral nor net additional to the atmosphere, and assuming so is inconsistent with the underlying science"); Beddington, John et al., Letter to EU Parliament regarding forest biomass (Jan. 9, 2018), http://empowerplants.files.wordpress.com/2018/01/scientist-letter-on-eu-forest-biomass-796-signatories-as-of-january-16-2018.pdf.

[53] Sterman, John et al., Does wood bioenergy help or harm the climate?, 78 Bulletin of the Atomic Scientists 128 (2022), DOI: 10.1080/00963402.2022.2062933.

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Research also shows that using forest "residue" or "waste" for energy—referring to biomass that would otherwise be disposed of—is not carbon neutral and leads instead to a *net increase* of carbon emissions in the atmosphere for decades.[55] One recent study found that burning all wood types, including forest residues (defined as branches, tree tops and bark) and fire-killed trees, to generate electricity increases carbon emissions in the atmosphere for more than a century compared to generating that electricity with fossil gas.[56]

Biomass proponents also falsely claim that cutting trees ("thinning") for biomass energy will reduce wildfire severity and lead to an overall net carbon benefit. Yet published scientific research on this issue has debunked this blanket claim. Broad-scale thinning to reduce fire risk or severity leads to more carbon emissions than it prevents from being released in a wildfire and creates a long-term carbon deficit that worsens the climate crisis.[57] Similarly, biomass proponents often claim that cutting dead trees after fire—frequently done as clear-cutting—is needed to reduce fire risk and leads to an overall carbon benefit. However, published research shows that dead trees do not increase wildfire risk (including no increase in fire severity, rate of spread, or extent).[58] Moreover, dead trees left standing in a forest provide critical carbon storage post-fire by retaining the vast majority of their carbon even after large, intense burns.[59]

All methods to convert woody biomass to hydrogen, such as gasification and pyrolysis, produce high emissions of CO_2 and other air pollution that harm the climate and communities.

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[55] Booth, Mary S., Not carbon neutral: Assessing the net emissions impact of residues burned for bioenergy, 13 Env't Rsch. Letters 035001 (2018), https://doi.org/10.1088/1748-9326/aaac88; Sterman, John et al., Does wood bioenergy help or harm the climate?, 78 Bulletin of the Atomic Scientists 128 (2022), https://doi.org/10.1080/00963402.2022.2062933.

[56] Laganiere, Jerome et al., Range and uncertainties in estimating delays in greenhouse gas mitigation potential of forest bioenergy sourced from Canadian forests, 9 GCB Bioenergy 358 (2017), https://doi.org/10.1111/gcbb.12327.

[57] Campbell, J.L. et al., Can fuel-reduction treatments really increase forest carbon storage in the western US by reducing future fire emissions?, 10 Frontiers in Ecology and Env't 83 (2012), https://doi.org/10.1890/110057; Hudiburg, Tara W., et al., Meeting GHG reduction targets requires accounting for all forest sector emissions, 14 Env't Rsch. Letters 095005 (2019), https://doi.org/10.1088/1748-9326/ab28bb; Bartowitz, Kristina J. et al., Forest carbon emission sources are not equal: putting fire, harvest, and fossil fuel emissions in context, 5 Frontiers in Forests and Global Change 867112 (2022), https://doi.org/10.3389/ffgc.2022.867112; Hanson, Chad, Cumulative severity of thinned and unthinned forests in a large California wildfire, 11 Land 373 (2022), https://doi.org/10.3390/land11030373; Law, Beverly E. at al., Creating strategic reserves to protect forest carbon and reduce biodiversity losses in the United States, 11 Land 721 (2022), https://doi.org/10.3390/land11050721.

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[59] Most combustion during wildfire comes from needles and small branches less than 2 centimeters in diameter. Campbell, John et al., Pyrogenic carbon emission from a large wildfire in Oregon, United States, 112 J. of

Proposals to capture CO_2 emitted during hydrogen production with CCS are unsafe, ineffective, expensive, and target environmental justice communities. For example, CCS risks inevitable leakage of compressed CO_2 from pipelines and underground storage, posing major safety risks to communities and exacerbating climate change; large-scale industrial CCS projects regularly fail to meet their carbon capture targets, as discussed above; CCS requires high energy inputs (i.e., it takes a lot of energy to separate, compress, transport, and inject CO_2, typically requiring at least 15-25% more energy) that result in increased GHG and air pollution emitted from CCS facilities; and proposals for CCS are targeting communities in the Central Valley already overburdened with pollution, worsening environmental injustice. Gasification and pyrolysis of biomass to make hydrogen also produce climate-damaging methane and bio-oil which emit CO_2 to the atmosphere when burned. Incentivizing the production of hydrogen from woody biomass would also increase forest logging and thinning which degrade wildlife habitat and result in a net loss of carbon storage from forests, at a time when we must be reducing deforestation and protecting forest carbon stores. Therefore, the LCFS should not include future pathways for forest biomass as a "low-carbon" source of electricity, hydrogen or other transportation fuel, since these fuels are highly polluting for the climate and communities.

Thank you,

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