May 31, 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 Draft Proposed Changes for Tier 1 Hydrogen Simplified Calculator and Lookup Table Values

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

The Center for Biological Diversity, Leadership Council for Justice and Accountability, the Center for Food Safety, Center on Race, Poverty & the Environment, and Communities for a Better Environment appreciate the opportunity to comment on CARB’s proposed changes to the Tier 1 Hydrogen Simplified Calculator and Lookup Table Values under the Low Carbon Fuel Standard. However, we have concerns regarding the underlying assumptions of the calculator and lookup table, which we discuss here:

1) CARB’s CA-GREET model, on which the calculator is based, currently relies on assumptions for methane leakage that dramatically underestimate leakage rates and are inconsistent with the best available science. The result is an underestimate of the carbon intensity of hydrogen made from fossil gas or biogas.
2) Hydrogen is an indirect greenhouse gas, meaning that leakage during its transport and distribution would indirectly contribute to global warming. This effect must be considered in determining the carbon intensity of hydrogen production.
3) Hydrogen produced by renewable-powered electrolysis could divert renewable capacity from the grid where it could be more efficiently used. This diversion could force the substitution of fossil fuel use in the power the grid. Should this occur, the emissions from the indirect promotion of fossil fuel use should be factored into the calculation of hydrogen carbon intensity.
4) The GREET model fails to accurately account for the GHG emissions associated with factory farm gas in ignoring several sources of upstream and downstream emissions. As a result, CARB significantly overstates the negative carbon intensity (CI) of factory farm gas.
5) A Tier 1 calculator is inappropriate for hydrogen pathways. This tier is supposed to be reserved for pathways that CARB staff have extensive experience evaluating. Since hydrogen production is a new and evolving industry, hydrogen pathways do not fit this criterion and should, at a minimum, be relegated to Tier 2.

Prior to addressing these specific concerns, we would like to voice our overarching opposition to the allowance of any pathways that rely upon fossil gas, biogas, or biomass for fuel production. There should be no hydrogen pathways that employ these harmful feedstocks given that clean solar and wind energy are available. It is well-established that fossil gas,[1] biogas,[2] and biomass[3] are both exceptionally carbon intensive and environmentally destructive and therefore should have no role in a carbon-free, healthy climate future. With this overarching concern as context, we discuss specific issues with the calculator below.

I. CARB's CA-GREET Model Underestimates Methane Leakage for Fuels made with Fossil Gas and Biogas and Must Be Updated to Match Prevailing Science.

The proposed Tier 1 Hydrogen Calculator cites GREET 2022 as the source for its emissions factors for hydrogen production. However, GREET 2022, and therefore CA-GREET that builds on it, relies on assumptions for methane leakage that dramatically underestimate leakage rates and are inconsistent with the best available science. As a result, the calculator likely underestimates the carbon intensity of hydrogen made with fossil gas and biogas, since it fails to fully account for methane leakage. The GREET model assumes that the upstream leakage rate for both conventional and shale natural gas is 1%.[4] The draft CA-GREET 3.0 Lookup Table Pathways document presents slightly larger values based upon GREET 2022 of 1.29% and 1.36%, respectively,[5] but these are still 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 up to over twice the rates used in the CA-GREET model.[6]

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%,[7] 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

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

[2] 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; 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.

[3] 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; 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.

[4] Elgowainy, A. et al., Hydrogen Life-Cycle Analysis in Support of Clean Hydrogen Production, Argonne National Laboratory, Energy Systems and Infrastructure Analysis Division (October 2022).

[5] California Air Resources Board, Draft Lookup Table Pathways Technical Support Documentation (February 21, 2023).

[6] Alvarez, Ramon A. et al., Assessment of methane emissions from the U.S. oil and gas supply chain, 361 Science 186 (2018); Howarth & Jacobson, How green is blue hydrogen?, 9 Energy Sci. Eng. 1676 (2021).

[7] 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%,[8] 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.[9] 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.[10]

Methane is a super-pollutant more than 80 times more powerful than CO_2 at warming the atmosphere over a 20-year period,[11] second only to CO_2 in driving climate change.[12] 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."[13] 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.

II. CARB Must Account for the Indirect Greenhouse Gas Effects of Hydrogen Leakage in Defining the Carbon Intensity of Hydrogen Pathways.

The draft hydrogen calculator considers the emissions from transporting finished hydrogen product, but there is no mention of emissions from hydrogen leakage. Hydrogen is an exceptionally small molecule, even smaller than methane, and therefore is difficult to contain. It is known to easily leak into the atmosphere throughout the production and supply chain. This is of great concern because hydrogen is considered an indirect greenhouse gas: it contributes to climate change by increasing the amounts of other greenhouse gases in the atmosphere such as methane, ozone, and water vapor. As a result, it has 100 times the warming power of carbon dioxide over a 10-year period and 33 times over 20 years.[14] The hydrogen calculator must have an accounting of hydrogen leakage in order to produce a more accurate estimate of any pathway's carbon intensity. Otherwise, the true climate harms of any given hydrogen pathway

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[8] *Id.*

[9] 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.

[10] 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.

[11] 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.

[12] 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

[13] *Id.*

[14] Ocko, Ilissa & Steven Hamburg, Climate consequences of hydrogen emissions, 22 Atmos. Chem. Phys. 9349 (2022).

will be underestimated. Insofar as studies quantifying hydrogen leakage are scarce, CARB must bolster its modeling by seeking out or commissioning studies meant to address this data gap.

III. CARB Must Account for Potential Substitution Effects of Diverting Renewable Energy from the Grid for Electrolytic Hydrogen Production.

Hydrogen produced by electrolysis has not reached commercial scale so, at present, renewable solar and wind energy that is produced in California is devoted to the energy grid. However, if electrolytic hydrogen reaches commercial scale, then it could mean taking renewable energy otherwise slated for direct use in the grid and diverting it to hydrogen production. The extent of this will depend on whether any renewable energy comes online in coordination with electrolytic hydrogen facilities coming online. If renewable energy does not come online to compensate for increased demand from electrolysis, then the production of electrolytic hydrogen might lead to indirect emissions—a possibility not currently accounted for in the calculator. Essentially, in taking renewable energy that could be used in the grid, to meet power sector demand, the grid may have to instead rely on fossil fuel sources like carbon intensive fossil gas. Thus, a greater benefit could come from putting solar and wind-generated energy directly into the grid to displace fossil fuels rather than diverting energy to hydrogen production. In the event of electrolytic hydrogen production indirectly spurring fossil fuel use, the resulting carbon emissions would be attributable to hydrogen and therefore part of its carbon intensity. CARB must do a proper accounting of this potential in order to produce more accurate electrolytic hydrogen pathway carbon intensity estimates.

IV. The GREET Model Fails to Accurately Account for the Large GHG Emissions Associated with Factory Farm Gas Production.

As part of the proposed Tier 1 calculator, CARB relies on artificially negative CI scores for factory farm gas as a result of the GREET model's overly narrow system boundary. Despite the significant emissions associated with manure production and digestate handling, GREET fails to accurately account for the large GHG emissions associated with factory farm gas production. By using such a narrow system boundary, CARB does not account for upstream and downstream emissions and thereby allows for life cycle analyses that omit significant greenhouse gas emissions and result in unscientific and erroneous carbon intensities.

That CI calculation is supposed to include several life cycle stages, including but not limited to "feedstock production and transport; fuel production, fuel transport, and dispensing; co-product production, transport and use; waste generation, treatment and disposal; and fuel use in a vehicle."[15] Instead of faithfully applying the regulations to factory farm gas, CARB excludes many necessary project elements from the system boundary. Upstream, factory farm gas calculations ignore feed production and transport as well as enteric emissions. Downstream, these calculations ignore emissions from digestate handling, use, and disposal. As a result, CARB significantly overstates the CI negativity of factory farm gas.

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[15] Cal. Code of Regs. Tit. 17 § 95488.7(a)(2)(B).

CARB must conduct a complete well to wheel analysis and update the CI value of factory farm gas to reflect this analysis, as required by the regulations, before passing along that inaccurate negative CI as a feedstock for both SMR and electrolytic hydrogen.

V. A Tier 1 Calculator is Inappropriate for Hydrogen Pathways

CARB proposes that Hydrogen pathway applications should be evaluated using a Tier 1 calculator. A Tier 1 pathways classification should apply to "fuel pathway categories that the Board's staff has extensive experience evaluating."[16] This does not apply to hydrogen pathways. Although CARB has approved hydrogen pathways, hydrogen production in California is a new and evolving industry. This is significant ongoing work on hydrogen production in the legislature, state agencies, and the state's application to the Department of Energy via ARCHES. Further, the Tier 1 application process provides no public comment period. Given the impacts to nearby communities discussed throughout this letter and the emerging nature of hydrogen production, the public should have the opportunity to review pathways applications and provide feedback to CARB. For these reasons CARB should, at a minimum, convert this into a Tier 2 calculator.

Thank you,

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[16] Cal. Code Regs. tit. 17 § 95488.1

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