May 6, 2024

Carolyn Lozo, Chief, Low Carbon Fuels Standard
Matthew Botill, Chief, Industrial Strategies Division
California Air Resources Board
Per email: LCFSWorkshop@arb.ca.gov

Dear Ms. Lozo and Mr. Botill:

We were gratified to note, when CARB postponed the March 21st hearing on the Low Carbon Fuel Standard program, that your reasons included:

> Staff continues to receive substantial feedback on the proposed regulatory package and is postponing the March hearing *to enable additional discussion and re-evaluation of the carbon intensity benchmarks…*

With this letter, we submit comments on three significant points regarding the "avoided emissions" carbon intensity benchmarks of the LCFS.

The first looks at the effect that high negative carbon intensity credits are having on the development of green electrolytic hydrogen in the LCFS, and the potential deleterious national effects related to Treasury rules on use of these "methane offsets." *Avoided emissions credits could allow fossil-based hydrogen to qualify for clean hydrogen tax credits.*

The second looks at the counterfactual that is at the basis of awarding negative credits. And the third looks at the effects on assumptions about livestock biogas carbon intensity in the context of empirical leakage rates.

We have submitted a petition to CARB asking that the regulations for livestock methane required in SB 1383 be implemented.[1] If this were to occur, it would automatically eliminate the avoided emissions credits for California operations – except those with existing contracts. Regulation could be innovative, as in the Union of Concerned Scientists proposal for a Low Carbon Milk Standard.[2] With regulation in place, LCFS could, and should require biogas from other states to be regulated as well in order to participate in the LCFS.

Alternatively, the LCFS could simply eliminate all avoided emissions credits, except for existing contracts, starting in 2025. This is fully justified based on the fact that the many government and private subsidies, including LCFS, have turned livestock biogas into a commodity. Capture of biogas has become "business-as-usual" and thus should not qualify for avoided emissions CI scores.

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[1] https://actionnetwork.org/user_files/user_files/000/106/944/original/2024-03-01_Petition_to_regulate.pdf a slide presentation is at: https://my.visme.co/v/319j003r-zz6wqv#s1

[2] https://blog.ucsusa.org/jeremy-martin/something-stinks-california-must-end-manure-biomethane-accounting-gimmicks-in-its-low-carbon-fuel-standard/#:~:text="The%20carbon%20intensity%20of%20dairy,on%20characteristics%20of%20the%20digester. Feb. 15, 2024.

In addition:

- CARB should recalculate carbon intensity scores for livestock biogas. Recognizing biogas as a commodity means that milk and methane should be treated as co-products in a life-cycle assessment (LCA).
- Require monitoring of controlled and fugitive emissions for digesters and biomethane plants. A mature set of technologies exists to accomplish this.[3]
- Change LCA standards to penalize leakage levels that make biogas carbon intensive – including nitrous oxide emissions from spreading of the digestate.
- Correcting the spurious avoided emission carbon intensity scores will allow CARB to award the lowest score, and greatest value, to clean, renewable electricity, and accelerate the LCFS goal of supplanting biofuels with electricity. Providing a credit multiplier for zero-emission fuels would also accelerate this shift.
- CARB should work with the cap-and-trade program, the Energy Commission, and the Legislature to establish a statewide policy incentivizing green electrolytic hydrogen that meets the three pillars standard. Only hydrogen produced this way should be incentivized by the state.

Lest we forget:

> "Without substantial reductions, GHG emissions from the global food system alone would make 1.5°C an impossible temperature limit. Food systems account for ~33% of global GHG emissions, and livestock production alone accounts for ~50% of that amount despite delivering just 18% of calories and 37% of protein to the global food system. *By 2030 alone, on a business-as-usual trajectory, emissions from the livestock sector will take almost 50% of the GHG emissions budget consistent with limiting global temperature rise to 1.5°C."*[4]

Thank you for your consideration of these comments, and the attachment.

Daniel Chandler, Ph.D.
350 Humboldt
Steering Committee

Janet Cox, CEO
Climate Action California

Will Brieger,
350 Sacramento
Legislative Team

[3] Odeh, N., and M. Abu-Ebid. "Methodology to assess methane leakage from AD Plants_Part I: Report on proposed categorization of AD plants and literature review of methane monitoring technologies." (2016).
[4] https://animal.law.harvard.edu/wp-content/uploads/Paris-compliant-livestock-report.pdf

Comments on the "Avoided Emission" Credits in LCFS

Contents:

A. The dangers of "methane offsets" in the production of hydrogen

Two well-respected policy analysts, Danny Cullenward and Elizabeth Grubert, have argued that the high carbon intensity scores awarded "avoided emissions" for dairy biogas amounts to a "methane offset." And that in the context of Treasury's upcoming rules on 45V tax credits, these may be pernicious.

> The logic goes like this: If someone else was going to emit methane to the atmosphere, but agrees instead to capture and inject it into a gas pipeline network, then a hydrogen producer can buy a certificate from that other methane producer representing that same captured gas and potentially treat their *own* fossil gas as negative emissions….Because methane is considered almost 30 times more impactful than CO2 over a 100-year period, the CO2- equivalence of avoiding methane emissions is larger than the project's direct CO2 emissions, and therefore the resulting hydrogen production process gets a negative carbon intensity score.
>
> "Without methane offsets, fossil hydrogen projects couldn't benefit much from the hydrogen [IRA 45V] tax credit; even with strict carbon capture and storage pollution controls, they can't meet the life cycle requirements for the top tier and would likely prefer to claim a smaller carbon storage tax credit instead. But if projects can use methane offsets, they can easily reduce their calculated emissions to qualify for the top tier of the hydrogen production tax credit. This would also mean these fossil projects could undercut truly clean hydrogen projects.
>
> "Remarkably, a fossil hydrogen project without carbon capture could qualify for the top production tax credit by offsetting just 25% of its fuel use. And a fossil hydrogen project that abates 90% of its CO2 emissions could earn the top tier of the tax credit if it bought offsets for just 4% of its fuel use. [5]

[5] Emily Grubert & Danny Cullenward. "The New Hydrogen Rules Risk Opening the Door to Methane Offsets: Having a true green hydrogen industry depends on that not happening." February 09, 2024. https://heatmap.news/climate/hydrogen-tax-credit-final-methane-offsets

Cullenward and Grubert are making this point in the context of tax credits for hydrogen producers when the goal is to get a brand-new industry of green electrolytic hydrogen off the ground in only a few years. Methane offsets, pre-eminently those of the LCFS, threaten to allow fossil fuel companies to divert these tax credits to hydrogen produced by steam methane reformation (SMR). Thus, what began as a well-intentioned attempt to reduce transportation emissions in California while also abating agricultural methane has turned into a model that threatens the national development of green electrolytic hydrogen!

B. LCFS "avoided emissions credits" are a disincentive to developing a green hydrogen industry in California

California's goal should be, like that of the federal government, to incentivize green hydrogen. What is meant by green hydrogen? The Treasury has provided several tiers, with much higher incentives for electrolytic hydrogen powered by new renewables (additionality) that are co-located and matched in time with production. Unfortunately, the LCFS has none of the guard rails that Treasury is considering and as a result is incentivizing fossil-based hydrogen but not green electrolytic hydrogen. It should not matter that LCFS incentivizes hydrogen production in the specific context of transportation. There should be *one* California-wide policy to incentivize green electrolytic hydrogen that follows the three pillars.[6]

It is arguable whether, as in the IRA, somewhat higher carbon intensity production methods should also be incentivized but to a lower extent. Hydrogen made from methane using SMR has a carbon intensity of double what the IRA will incentivize. So that should clearly not be a candidate, but hydrogen made from gasification of woody biomass from forest residues might be a candidate based on lower carbon intensity and social usefulness. Through the wonders of chemistry there are actually many pathways with lower carbon intensity than SMR-based hydrogen. Climate Action California, however, believes that only green electrolytic hydrogen should be *incentivized* by the state of California. That is the only way the clean hydrogen industry we need will come into being.

Under the LCFS currently, hydrogen producers using SMR and other carbon intensive production methods are incentivized because they can buy avoided emissions credits allowing them to offset the emissions associated with carbon intensive hydrogen production which otherwise entail penalties or they can use dairy biomethane as a feedstock.

Table 1, below, shows the feedstocks used in producing hydrogen credited under the LCFS.[7] Each feedstock is associated with a particular average carbon intensity. Those using methane from livestock digesters have an average negative carbon intensity of at least -200. Note that of the 116 pathways, only one is for green electrolytic hydrogen and its carbon intensity is rated at

[6] Additionality, co-location and time-matching are referred to as "the three pillars," and they appear to be certain in the Treasury Departments 45V rules for the highest tier of subsides ($3 per kg of H2 with a carbon intensity of 0.45 kgCO2e/kg H2). The lowest tier eligible for subsidies earns only $0.60 and must meet a 4 kg CO2e/kg H2 standard. See: https://www.resources.org/common-resources/how-can-hydrogen-producers-show-that-they-are-clean/ The carbon intensity common for SMR hydrogen is in the neighborhood of 9 kg CO2e/kg H2. https://www.iea.org/data-and-statistics/charts/comparison-of-the-emissions-intensity-of-different-hydrogen-production-routes-2021

[7] The data in Table 1 and Table 2 are from the publicly available LCFS files, accessed December 6, 2023: https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/fuelpathways/current-pathways_all.xlsx

zero, far above the negative scores for manure feedstocks. Of the 116 facilities 89% are in California.

Table 1: Carbon intensity[8] of LCFS pathways[9] for hydrogen, by feedstock

Feedstock	N	Mean of Carbon Intensity
Any Other Feedstock (998)	1	88
Dairy Manure (026)	39	-202
Fossil NG & Landfill Gas	2	44
Grid Electricity (039)	2	164
Landfill Gas	2	-9
Landfill Gas (025)	24	112
North American Fossil NG (031)	30	142
North American NG	1	166
North American Natural Gas	1	151
Sodium Chlorate Production Process	1	56
Solar Electricity via Electrolysis	1	0
Swine Manure (044)	6	-354
Wastewater Sludge (030)	2	93
Zero-CI Sources (037)	4	11
Total	116	-17

Above, 45 of 116 hydrogen pathways use livestock manure as a feedstock (39%). Though comprising less than half of the pathways, it is enough to make the whole hydrogen production system in the LCFS have a mean negative carbon intensity score.

Below we present the same table limited to those pathways where hydrogen is made by steam methane reformation.

Table 2: Carbon intensity and feedstock for the 74 pathways using Steam Methane Reforming to produce hydrogen.

Feedstock	N	Mean of Carbon Intensity
Dairy Manure (026)	30	-201
Landfill Gas (025)	16	107
North American Fossil NG (031)	19	141
North American Natural Gas	1	151
Swine Manure (044)	6	-354
Wastewater Sludge (030)	2	93
Total	74	-46

[8] **Energy Economy Rate-adjusted Carbon Intensity (gCO2e/mj) – amount of carbon emitted in producing and consuming a megajoule of energy.*

[9] For the purposes of this analysis we used all of the LCFS data. Many of these pathways, however, have been retired, including 37 whose fuel category is "hydrogen." In short, the tables show an overview of the history of the program, not just the currently active pathways.

Livestock manure is a feedstock for 49% of hydrogen producers using SMR.

The difference in carbon intensity between using fossil methane and methane from manure is extreme, showing the effects of a mistaken "avoided emissions" counterfactual. There is no difference in the physical methane used as a feedstock or the hydrogen produced – just the "magic" of avoided emissions crediting if the feedstock is manure.

C. The specious nature of "avoided emission" credits for livestock manure biogas capture

Regulation and the counterfactual of avoided emissions

There is probably no one who cares about global warming who does not recognize the need to abate methane as quickly as possible. Yet in California the majority of methane emissions are unregulated, coming from livestock and to a smaller extent rice. Overall, out of 115 MMT of CO2e20 methane, 63MMT belong to livestock and is unregulated (*2020 Emissions Inventory*).

SB 1383 governs methane and other short-term pollutants in California. It calls for CARB to adopt regulations for livestock methane by 2024. We have submitted a petition to CARB asking that the law be followed. If CARB *were* following the law, the emissions attributed to voluntary action by dairy and other farmers would already be required, so high negative emissions credits would not be permissible.

Incentives and the counterfactual of avoided emissions

However, there is another way to view the issue. Matthew Botill posed this question, "If we can achieve the SB 1383 40% reduction by incentives why would we regulate?" So, CARB appears to be viewing incentives as an alternative to regulation but designed to accomplish the same mitigation goal. To that end, many incentives for capturing methane are available. Dr. Kevin Fingerman has looked at all of the sources of funding for digesters.[10] These include cap-and-trade, DDRDP, federal RIN credits, the CPUC, Aliso Canyon Settlement funding, the California Energy Commission, and the federal REAP fund as well as roughly 2.5 billion over ten years through LCFS. (This is not government money, but it would not exist without a government structured program.) The total cost to abate a ton of CO2e via a digester is $159 (far above the $9 cited in the 2022 CARB SB 1383 status report).[11] Economist Aaron Smith has calculated that for LCFS, specifically, the cost for abating a ton of CO2e through the avoided emission credits is $167.[12] Seemingly CARB thinks that the incentives are sufficient to reduce livestock emissions by the required 40% in 2030. So, in this case very generous incentives (enough to establish a whole new biomethane industry in California) are *substituting* for regulation. If this is the case, though, in what sense should the dairy emissions be considered as voluntary actions to reduce emissions? If there were no government incentives (which amount to about $28 per metric ton of methane) you could argue that individual farmers who install digesters are in fact avoiding

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[10] Wakeman, D. and Fingerman, K. (2023). *Waste stream to revenue stream: calculating the costs and climate impact of California's investments in dairy digester infrastructure*. Arcata, CA. The work was performed for the Center for Food Safety.

[11] California Air Resources Board. A*nalysis of Progress toward Achieving the 2030 Dairy and Livestock Sector Methane Emissions Target (March 2022).*

[12] Smith, Aaron. "Cow Poop is Now a Big Part of California Fuel Policy" Energy Institute Blog, UC Berkeley, January 22, 2024, https://energyathaas.wordpress.com/2024/01/22/cow-poop-is-now-a-big-part-of-california- fuel-policy/

emissions. But with incentives set so high that CARB top administrators believe they nullify the need for regulations, the concept of avoided emissions does not make sense. In fact, forty-two California dairies are among the 58 earning LCFS credits *and* among those with funding from the DDRDP incentives.[13] The total reductions in ten years claimed for these 42 dairies by the DDRDP is 9,113,976 MTCO2e. The point here is not that there is double counting (LCFS does not require additionality) but that for those 42 dairies the farmers had already been paid to reduce the emissions the LCFS claims *it* is avoiding.

LCFS is governed by the following provision in the Compliance Offset for Livestock: "Eligible offsets must be generated by projects that yield surplus GHG reductions that exceed any GHG reductions otherwise required by law or regulation *or any GHG reduction that would otherwise occur in a conservative business-as-usual scenario*."[14] The extensive subsidies available and used by dairies already account for the digester reductions since they "occur in a conservative business-as-usual scenario" of multiple private and government funds independent of LCFS. Investors have turned manure methane from a waste product to a commodity. Dairies with digesters now sell both milk and methane. *The concept of avoided emissions requires a counterfactual that, because of extensive subsidies does not, in fact, exist.*

In summary, since everyone knows methane must be abated, and CARB is specifically required by state law to regulate livestock methane by 2024, no magic dust in the form of "avoided emission" counterfactuals should be permitted. Eliminating "avoided emission" carbon intensity scores would mean the carbon intensity assigned livestock methane would be more in line with that of landfill gas (roughly 53 rather than the -321 average of dairy gas). If, on the other hand, government is providing or arranging for handsome profits for a new industry which makes farmers very interested in making manure methane a commodity, then again the high credits due to avoided emissions should not apply, as the counterfactual is erroneous.

D. The GREET model does not capture all the variables required in order to accurately predict methane and nitrous oxide reduced by anaerobic digesters.

Life cycle effects of digesters must include the entire farm over time.

There have now been a variety of studies that show the variability of emissions reductions attributable to anaerobic digesters, including the possibility that emissions are *greater* with a digester. For example, a recent Canadian study[15] found a 27% *increase* in GHG emissions when a digester was added to a lagoon system – primarily due to three times more emissions from digestate when applied to the soil. CARB's model, however, excludes nitrous oxide emissions from land application so this effect is not captured.[16]

A second study is of two dairies that installed digesters and monitored them over five years. GHG emissions *increased* over the baseline after two years, probably because food wastes

[13] We also checked the Pathway 2 applications that are pending LCFS approval at https://ww2.arb.ca.gov/resources/documents/lcfs-pathways-requiring-public-comments Two of five California dairies also had DDRDP grants.
[14] CARB Compliance Offset Protocol: Livestock Projects – Capturing and Destroying Methane from Manure Management Systems. Adopted: November 14, 2014. Our italics.
[15] Maldaner, Lia de Sousa. "A life-cycle assessment of greenhouse gas emissions associated with on-farm biogas production." PhD diss., University of Guelph, 2017.
[16] CARB Compliance Offset Protocol: Livestock Projects – Capturing and Destroying Methane from Manure Management Systems. Adopted: November 14, 2014.

were added as a feedstock without additional protections from fugitive gas leaks.[17] Food waste as a feedstock is not included in the CARB model.

In general, the CARB compliance offset model is very detailed, but the precision is questionable (apart from what is not included in the modeling) as most emissions factors are based on an IPCC Expert Group and only one or two studies. The model has not been updated with results from many more recent studies. The approach by the International Council on Clean Transportation, which focuses on specifying and accounting for uncertainties, is – considering the stakes of the climate crisis – far better than the false precision of the LCFS carbon intensity scores.[18]

Life cycle effects of digesters must include the leakage from both the collection system and the biomethane upgrading and distribution system.

The CARB model assumes leakage of 5%. Since leakage over 2% in a natural gas system makes it dirtier than coal, even that amount would seem to be troubling.[19] The 5% is intended to cover leakage at the digester as well as in the upgrade to biomethane. However, the IPCC assumes 10% leakage.[20] And the 2008 California Climate Action Registry default value was 15%.[21]

Empirically, average leakage from a study of 23 biomethane plants is 4.6%, with a range of 0.4 to 14.9%.[22] A 2020 study judged that methane leaks from the process of making "renewable natural gas" is greater than that from flaring, making RNG a more climate destructive process.[23] A 2011 study of a single technologically advanced digester found large differences in leakage rates over time, with the largest being 26.6 kg CH4 hr^{-1}.[24] This leakage rate range has been explicitly modeled for California digesters using CARB's emission factor as a baseline. Capture

[17] Debruyn, Zachary, Andrew VanderZaag, and Claudia Wagner-Riddle. "Increased dairy farm methane concentrations linked to anaerobic digester in a five-year study." *Journal of Environmental Quality* 49, no. 2 (2020): 509-515.
[18] Zhou, Yuanrong, Diana Swidler, Stephanie Searle, and Chelsea Baldino. "Life-cycle greenhouse gas emissions of biomethane and hydrogen pathways in the European Union." (2021).
[19] Howarth, Robert W., Methane Emissions from the Production and Use of Natural Gas. In Press, EM Magazine, the peer-reviewed trade journal of the Air & Waste Management Association, for December 2022 issue. https://foe.org/wp-content/uploads/2023/01/Howarth-Comments-on-Clean-Hydrogen-Production-Standard.pdf
[20] Jeong, Seongeun, Marc L. Fischer, Hanna Breunig, Alison R. Marklein, Francesca M. Hopkins, and Sebastien C. Biraud. "Artificial intelligence approach for estimating dairy methane emissions." *Environmental Science & Technology* 56, no. 8 (2022): 4849-4858.
[21] The registry is a state-founded nonprofit. The 15% figure, unless proven less, is from: Flesch, Thomas K., Raymond L. Desjardins, and Devon Worth. "Fugitive methane emissions from an agricultural biodigester." *Biomass and bioenergy* 35, no. 9 (2011): 3927-3935.
[22] Scheutz, Charlotte, and Anders M. Fredenslund. "Total methane emission rates and losses from 23 biogas plants." *Waste Management* 97 (2019): 38-46.
[23] Grubert, Emily. "At scale, renewable natural gas systems could be climate intensive: the influence of methane feedstock and leakage rates." *Environmental Research Letters* 15, no. 8 (2020): 084041.
[24] Flesch, Thomas K., Raymond L. Desjardins, and Devon Worth. "Fugitive methane emissions from an agricultural biodigester." *Biomass and bioenergy* 35, no. 9 (2011): 3927-3935. Flaring was a regular part of the operation of this digester and the high values were found during flaring.

of fugitive methane by digesters was reduced by nearly a third at the high end of the leakage range. [25]

It might be tempting to compare these leakage rates with the amount released if there were no digester, but the proper comparison is with other alternative fuel sources. That is, dairy gas credits are used to offset fossil fuels, so the leakage must be analyzed in that context. According to Grubert, "The estimated leakage range within which RNG becomes more GHG intensive than FNG is about 9.1–11.1% (GWP-100) or 5.0–6.6% (GWP-20).[26]

These leakage studies are based on on-the-ground measurements. The California Methane Survey has found intermittent and persistent leaks from dairy digesters in their aerial study of methane super-emitters.[27]

> In some cases, the intermittent emissions can be explained by normal operations (for example, periodic waste flushing at large dairies). In other cases, more persistent activity is apparently due to sustained venting at a small number of anaerobic digesters at dairies and wastewater-treatment plants, or to leaking bypass valves at natural gas compressor stations. We find a similar distribution of persistence (20–35% on average) and emissions in the manure-management, wastewater-treatment and oil and gas sectors.

The International Council on Clean Transportation states, "Using manure biomethane as an example, the GHG intensity of its central case is -30 gCO2e/MJ. Uncertainty in upstream methane leakage can lead to a range of manure biomethane GHG intensities of -44 gCO2e/MJ to 72 gCO2e/MJ…. [C]onsidering the uncertainty in these GHG intensities, manure biomethane might have more limited carbon reduction potential in the 100-year timeframe if methane leakage from its production process is high."[28]

If the methane from livestock manure is not voluntarily captured but incentivized as a commodity, as we argue, then not only will the theoretical carbon intensity become positive, but leaks (which are not monitored) diminish the value of using livestock methane to offset carbon intensive fuels (like SMR hydrogen) and should be fully accounted for.

E. Avoided emissions credits are not necessary for preserving or incentivizing capture of methane by California dairies.

Advocates of the dairy/biomethane industrial complex, like Michael Boccadero, say that digesters would not be feasible without the avoided emission negative carbon intensity scores. This is not true. Before the LCFS negative CI scores for biomethane, the cap-and-trade program funded hundreds of digesters around the country, most producing heat and electricity as well as

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[25] "We also estimate a CH_4 reduction potential of 83 Gg CH_4/yr, assuming CARB's EF for AD for these large facilities. When we vary the EF for AD from 3 to 20%, reflecting low to high leakage rates, the CH_4 reduction potential varies from 67 to 91 Gg CH_4/yr." Jeong op cit.

[26] Op cit.

[27] Duren, Riley M., Andrew K. Thorpe, Kelsey T. Foster, Talha Rafiq, Francesca M. Hopkins, Vineet Yadav, Brian D. Bue et al. "California's methane super-emitters." *Nature* 575, no. 7781 (2019): 180-184.

[28] Zhou, Yuanrong, Diana Swidler, Stephanie Searle, and Chelsea Baldino. "Life-cycle greenhouse gas emissions of biomethane and hydrogen pathways in the European Union." (2021).

products made from digestate. That much more future-friendly model has been eclipsed by the biomethane boom which in turn reflects the avoided emission scores.

“Renewable natural gas,” even without the avoided emission negative scores has a carbon intensity about half that of fossil methane, so biomethane sold via the LCFS can still be profitable. Dairy Cares reports there are 120 digesters operating and 236 digesters funded in California.[29] Only 58 are currently part of LCFS, so clearly the avoided emissions credits are not necessary for digesters to be profitable. Existing digesters have a contractual ten years of assured payment through LCFS. These agreements can be honored.

In short, not only does the counterfactual for using “avoided emissions” negative CI scores fail, but these scores are also not necessary.

Inadvertently, perhaps, LCFS has at least three tigers by the tail – mega-dairies, biomethane/RNG plants, and dirty hydrogen. The problem for CARB is how to let go before letting go becomes impossible in the face of billion-dollar industry lobbies. We have already seen two legislative attempts to limit avoided methane credits killed, one this year (AB 2870) by a power play which did not even permit the bill a committee hearing. And SB 1420, a very bad dirty hydrogen bill that appears to depend on avoided emissions credits, is already in Senate Appropriations. The best way out, and one that is already legislatively mandated, is simply to regulate all livestock methane.

[29] https://www.dairycares.com/dairy-digesters