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

Subject: Comment on Draft Amendments to the Low Carbon Fuel Standard (LCFS) Tier 1 Calculators

Dear Chair Randolph,

Thank you for the opportunity to comment on the Proposed Low Carbon Fuel Standard (LCFS) Amendments and updated Life Cycle Analysis (LCA) and Documentation. As a California-based consulting firm with over 10 years of experience in life cylce analysis for biofuels and alternative energy, Life Cycle Associates has actively participated in the LCFS program since its inception. We bring extensive experience in fuel life cycle anaylsis, having supported a wide variety of biofuel and alternative energy developers. Our work has been instrumental in securing government funding and approvals for numerous fuel pathways, and we have collaborated with agencies like CARB, EPA, and the states of Oregon and Washington to establish low-carbon fuel programs.

Drawing on this experience, we recommend the following minor changes to the proposed Tier 1 calculators. We believe our insights can help refine the calculators to better serve a broad range of fuel developers and accelerate the growth of alternative fuels in California.

Our specific comments and recommendations are summarized below.

Recommendation for Tier 1 Organic Waste (OW) Calculator: Recognize Diversity and Address N_2O Emissions in all Waste Treatments

It is critical that CARB recognize the complexity of organic waste management in California. The state's most recent waste characterization studies reveal a variety of organic materials ending up in landfills, from over 6 million tons of paper products to 4 million tons of food waste, over 2 million tons of wood products, more than a million tons of textiles, and over 200,000 tons of manure[1]. Moreover, the landscape of composting in California has evolved significantly since the inception of SB 1383, encompassing materials such as soiled paper products, bio-plastics, agricultural residues, and food processing wastes. These materials not only contribute to the state's compost production but are also an important part of its waste management strategy.

We support the recently added category of Recovered Organics (RO) in the Tier 1 OW calculator. However, there remains room for better accounting for emissions across all waste streams in California. Presently, only food scraps qualify for diverted N_2O credit, leaving other waste streams

[1] California Department of Resources Recycling and Recovery. (2022, November). 2021 Disposal Facility-based Waste Characterization Data Tables. Retrieved from https://calrecycle.ca.gov/wcs/dbstudy/

largely unaddressed despite their potentially significant N_2O emissions. It's worth noting that while methane holds about 30 times the potency of CO_2 over a century, N_2O is roughly 300 times more potent than CO_2 over the same period. Unlike methane, which dissipates relatively quickly, N_2O persists in the atmosphere for over a century, amplifying its long-term warming impact.

To accommodate the diverse nature of waste and the myriad waste management systems across California, the Organic Waste calculator would benefit from minor adjustments. We suggest:

- Introducing options to indicate the percentage of Other Organic Waste (OOW) diverted from composting, in addition to landfilling.
- Incorporating user inputs for site-specific baseline CH_4 emissions.
- Including user inputs for site-specific baseline N_2O emissions.

Figure 1 illustrates a potential layout for integrating these user-defined inputs.

Section 3: Static Operational Data	
3.1 Electricity Grid Region	
3.2 Grid Electricity EF (gCO_2e/kWh)	
3.3 Low-CI Electricity EF (gCO_2e/kWh)	
3.4 Distance to CNG Station (miles)	
3.5 LNG Facility ID	
3.6 Distance to LNG Facility (miles)	
3.7 Liquefaction EF (gCO_2e/gallon)	
3.8 Bio-LNG Trucking Distance (miles)	
3.9 Bio-LNG Truck Type	
3.10 OOW - % Diverted from Landfill	
OOW - % Diverted from Composting	
OOW - % Diverted from Other Treatment	
OOW - Baseline Site Specific CH_4 Emissions (g/wet kg feedstock)	
OOW - Baseline Site Specific N_2O Emissions (g/wet kg feedstock)	
OOW - % Diverted from other Treatment	
3.11 OOW - TDOC (% dry basis)	
3.12 OOW - DANF (%)	
3.13 OOW - Decay Rate (k)	

Figure 1. Proposed location of additional user defined and site specific inputs is outline in red.

Recommendation: Align Tier 1 Calculators with CA GREET4.0 Livestock Categories

In the CA GREET4.0 RNG tab, livestock categories include Beef, Dairy Cow, Dairy Heifer, Swine, Layer, and Broiler and Turkey (refer to Figure 2). However, the Tier 1 calculator for animal manure (tier 1 DSM) presently covers only dairy cow, heifer, and swine categories. We suggest minor changes to align the tier 1 DSM with CA GREET4.0: CARB should incorporate beef and poultry manure categories into the DSM, using corresponding baseline manure management emissions described in CAGREET4.0 (Figure 3). To reflect these changes, we propose renaming the Tier 1 Dairy and Swine Manure Calculator to the Tier 1 Livestock Manure calculator.

1.3) Assumptions for Anaerobic Digestion of Animal Waste

Source of Assumptions: U.S.

U.S.

	Beef	Dairy Cow	Dairy Heifer	Swine	Layer	Broiler and Turkey
Share of Livestocks	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%

Figure 2. Snapshot of CA GREET4.0 RNG Tab showing livestock categories

	Beef Feedlots [2]		Layer Operation		Broiler and Turkey Operation	
	Dry Lot	Liquid/Slurry	Anaerobic La	Poultry w/o	Pasture	Poultry w/o Litter
Manure Region Management System Usage (MS%)						
U.S. Average	100.0%	0.7%	12.9%	87.1%	1.0%	99.0%
Manure Management System MCFs						
U.S. Average	1.2%	30.4%	71.5%	1.5%	1.2%	1.5%
Direct N2O Emission Factors (kg N2O N/kg N)	0.02	0.005	0	0.001	0	0.001
N Loss Factors through Volatilization of NH3	23%	26%	54%	34%	0%	34%

Figure 3. Snapshot of CA GREET4.0 RNG Tab showing livestock categories

We also note that livestock manures, and especially poultry manure, emit significant amounts of N_2O under traditional management systems. These emissions are amplified by the increasing concentration of modern livestock and poultry operations. This concentration leads to an overabundance of nutrients, exceeding the capacity of nearby crops to absorb them. Without effective manure management solutions to distribute these excess nutrients, they accumulate in concentrated areas, creating "hotspots" with devastating environmental consequences. These consequences include, but are not limited to, the eutrophication of water bodies and the proliferation of harmful algal blooms[2].

Livestock manure-to-RNG pathways, including beef and poultry manure pathways, offer a promising solution. RNG facilities transform manure through anaerobic digestion, generating renewable natural gas (RNG) and valuable fertilizer byproducts. Distributing these byproducts efficiently addresses nutrient needs in areas beyond the immediate vicinity of the operation, reducing N_2O emissions and mitigating the impacts of nutrient concentration on watersheds.

[2] Bryant, Ray B., et al. "Poultry manureshed management: Opportunities and challenges for a vertically integrated industry." Journal of Environmental Quality 50.4 (2021): 1201-1213. https://doi.org/10.1002/jeq2.20273

Therefore, we urge CARB to consider included avoided N_2O emissions and fertilizer displacement benefits in all manure-to-RNG pathways. This would ensure accurate accounting of the environmental benefits associated with manure-to-RNG pathways, ultimately incentivizing their development and adoption.

We appreciate your attention to these comments and recommendations. Thank you for considering our input.

Sincerely,

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