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Liane M. Randolph
Chair, California Air Resources Board
1001 I Street
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Subject**:** Letter of Comment on Ethanol Pathway in GREET, Issue with Biogenic VOC for Proposed Amendments to the LCFS, posted December 19, 2023

Dear Chair Randolph:

Life Cycle Associates would like to take this opportunity to provide our comments on the dry mill corn ethanol pathway under CA LCFS. We wish to draw attention to an issue regarding the treatment of biogenic VOC emissions within the ethanol production and T&D phases, which have been incorrectly categorized as fully oxidized GHG emissions. Both the prior and current versions of GREET have incorporated fugitive VOC emissions as fully oxidized GHG emissions, thereby adding to the carbon intensity of corn ethanol's well-to-tank phase. Such miscalculation within GREET1 models has carried forward to CA-GREET models as well, permeating this issue to CA LCFS.

Given that the VOC's carbon source is inherently biogenic, it logically follows that it should be designated as carbon-neutral for the purposes of carbon intensity calculations, warranting a reevaluation of its current treatment within the model. The non-combustions VOC emissions at the production plant as well as during the T&D phase are calculated per the equation below:

Equation 1. Total VOC emissions Dry Milling Corn Ethanol w/o Corn Oil Extraction.

$$VOC\ \left(\frac{g\ CO2e}{MMBtu}\right) = \left(\frac{(\mathbf{2.239})}{76{,}330} \times 1.001 \times 1e^{6} \times 1.000\right) \times \frac{44}{14} + (6.667 + 13.082) \times \frac{44}{14} \times 0$$

Compared to its predecessor, the 2019 simplified sfe calculator correctly excluded the T&D VOC fugitive emissions as GHG emissions. However, the fugitive VOC emissions as GHG from the production phase were still incorrectly retained, resulting in a CI of about 0.087 g/MJ. The same calculation has been carried forward in the proposed simplified SFE calculator, as shown in Table 2 below.

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Table 1. Corn Ethanol Evaporative Emissions

CA-GREET4.0 Emission Factors and Specifications				
Category	Sub-Category	Name	Value	Unit
Fuel Production	Process Fuel	Natural Gas Combustion in Boiler	75,496	gCO_2e/MMBtu NG (LHV)
	Chemicals and Enzymes	Chemicals	2.02	gCO_2e/MJ ethanol (LHV)
		Cellulosic Enzymes Used	525	gCO_2e/lb enzyme (normalized)
	Coproducts	Default Distiller's Oil Moisture Content	1%	%W/%W
	Evaporative Emissions	Standard Value	0.0867	gCO_2e/MJ EtOH
	Denaturant	Default Blend Value	2.5%	%V/%V

There are two key issues to be corrected in the above calculation and thus the ethanol CI calculator.

1. Incorrect oxidation of VOC
   The fully oxidized conversion of the VOC from the production phase currently utilizes the standard factor of approximately 44/14, where 14 refers to the molecular weight of an average VOC molecule. However, the VOC fugitively emitted during ethanol production is essentially an ethanol molecule with a molecular weight of 46, not 14. Thus, the correct fully oxidized fugitive VOC emission should use the factor of (44/46) instead of (44/14).

2. It's all biogenic
   Most importantly, the origin of carbon in these fugitive VOC emissions is strictly biogenic. As all other biogenic carbon flows are treated carbon neutral under the ethanol pathway, these fugitive emissions should also be zeroed out and not be included in the ethanol pathway altogether.

Overall, the correct equation to calculate the GHG emissions from the fugitive VOC emissions is as follows:

$$VOC\ \left(\frac{g\ CO2e}{MMBtu}\right) = \left(\frac{(2.239)}{76{,}330} \times 1.001 \times 1e^{6} \times 1.000\right) \times \frac{44}{\mathbf{46}} \times \mathbf{0} + (6.667 + 13.082) \times \frac{44}{14} \times 0 = \mathbf{0}\ \frac{\boldsymbol{g\ CO2e}}{\boldsymbol{MMBtu}}$$

Correcting for this reduces the corn ethanol pathway CI by about 0.087 g/MJ as shown in the Table *1*. This may seem like a small number, but it should be noted that this is a systematic error which affects each and every certified corn ethanol pathway and every gallon of corn ethanol sold in California, and it also affects the Inflation Reduction Act (IRA). Over the total volume of corn ethanol sold, such a small change in CI generates a significant impact for the LCFS program. It is also critical from a consistency perspective to treat the emissions from all biogenic sources equally.

Note that the same issue applies to other biofuel pathways including biodiesel and renewable diesel. CARB has already zeroed out the GHG impact of the transport VOC emissions for these pathways based on comments we provided several years ago. However, since the source of VOC in the ethanol plant is not clearly identified as biogenic ethanol, CARB has not acted on the ethanol production component, which clearly appears to be fugitive ethanol.

Life Cycle Associates has previously shared this comment with Argonne National Laboratory as well as with CARB. The response from ANL was in agreement with the comments, however owing to their priorities, ANL has deferred this change to future. Our previous comment letter to

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CARB also describes in detail the exact calculation with references to the specific sheets and cells within the prevailing CA-GREET and GREET1 model.

More importantly, the GREET model defines the basis for GHG calculations under the LCFS. Scholars, students, analysts, and of course affected parties look to the model to define the methods for GHG analysis. So, simple math errors do not support confidence in the program and should be corrected to avoid misunderstandings.

Thank you for your consideration.

Best Regards,

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