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California Air Resources Board
1001 I Street
Sacramento, CA 95814
VIA ONLINE SUBMISSION

RE: GREET4.0 – Propane Carbon Intensity Calculation

The Western Propane Gas Association (WPGA) is pleased to submit its comments in response to the Low Carbon Fuel Standard (LCFS) Lookup Table Pathways, GREET4.0 proposed model. The feedback provided is to clarify assumptions underlying the GREET4.0 model that we believe still overcalculate the carbon emissions of conventional propane.

As mentioned in our previous letter, we would like to thank CARB staff for recognizing the value of renewable propane in decarbonizing "hard-to-electrify" segments of California, and for justly calculating a lower Carbon Intensity (CI) of conventional propane under the GREET4.0 proposed model (Lookup Table Pathways, Pg 24)[1]. That being said, we are also going to argue for adjusting the baseline CI for propane.

<u>CARB PROPANE CI CALCULATIONS</u>

According to the Table Pathways, GREET4.0 gives conventional propane a CI of 81.24 – and 79.25 if produced entirely from the natural gas refining process. Both CIs are directly comparable to the transportation electricity CI of 81. The proposed value for upstream emissions is 16.4 gCO2eq/MJ and combustion emissions is 64.84 gCO2eq/MJ for a total carbon intensity = 64.84 + 16.4 = 81.24 gCO2eq/MJ. In previous years and still today, CARB has been using numbers of 25% of propane obtained from natural gas refining and 75% from oil refining.

<u>ARGONNE NAT. LAB PROPANE CI CALCULATIONS</u>

In a 2020 study, Argonne National Laboratory demonstrated that 40.5% of propane was obtained from natural gas refining and 59.5% from oil refining in the state of California[2]. If the change was made to reflect Argonne's findings, the carbon intensity can be reduced from the currently proposed **81.24** gCO2eq/MJ to **80.67** gCO2eq/MJ. CARB's analysis was based heavily on assumptions within the market, and we believe data and analysis provided by Argonne addresses this uncertainty in the GREET model.

<u>CALCULATION FOR PURE PROPANE</u>

$C_3H_8 + 5(O_2 + 3.76\,N_2) = 3CO_2 + 4H_2O + 18.8\,N_2$ (complete combustion).

[1] https://ww2.arb.ca.gov/sites/default/files/classic/fuels/lcfs/ca-greet/lut_update_2023_2.pdf

[2] Backes, S. E., Beath, J., Sebastian, B., & Hawkins, T. R. (2020, September). Sources of Propane Consumed in California. Chicago; Argonne National Laboratory.

1 mole of propane produces 3 moles of CO2 by the above equation.

Propane's molar mass or molecular weight is 44.097 g/gmol. CO2's molar mass is nearly the same at 44.01 g/gmol.

1 kg of propane will produce 3*44.01/44.097 ~ 3kg of CO2 = 3,000 grams of CO2.

Propane's lower heating value is approximately 84,250 BTU/gallon and density is 4.2 lb/gallon. This equates to an energy density of 84,250/4.2 = 20059.5 BTU/lb = 44,223.2 BTU/kg = 46.66 MJ/kg.

1 kg of propane has 46.66 MJ of energy and produces 3,000 grams of CO2.

Combustion emissions is 3,000 gCO2/46.66 MJ of energy = **64.29** gCO2/MJ.

CALCULATION CONCLUSIONS & CONSIDERATIONS

Increase in propane from natural gas share and less from oil share drops the CI from **81.24** gCO2eq/MJ to **80.67** gCO2eq/MJ. Assuming transport distance in California to be fewer than 200 miles for propane delivery, GHG emissions can be reduced another 0.35 gCO2eq/MJ = **80.32** gCO2eq/MJ. Using school bus CO2eq emissions from the GREET 2021 tool, another 0.26 gCO2eq/MJ can be shaved off.

As a result of these calculations, the Carbon Intensity of conventional propane is more accurately reflected to be **80.06** gCO2eq/MJ.

WPGA appreciates the opportunity to submit feedback on the LCFS GREET4.0 Lookup Table. We are happy to engage with CARB staff to bolster their calculations and assumptions under the next draft of the model for propane.

Sincerely,

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