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External Peer Review of “**Methodology in Calculating Fuel Carbon Intensities and Use of Three Greenhouse Gas Emissions Models**”

Overall summary statement: After reviewing the three staff reports describing the CI calculation methodology being proposed by CARB, I am confident that the methods are based on sound science and represents the state of the art in CI estimation.

With respect to the three staff reports that I reviewed, I have the following more specific questions and recommendation:

Life Cycle Fuel Carbon Intensities

Page 2. It would be useful to add a sentence or two in this overview report describing efforts by CARB to ensure that there is no double counting of emissions burdens between CA-GREET and the OPGEE modeling estimates.

Page 5. The CA-GREET model has been updated recently to include cellulosic feedstocks and sorghum. A cellulosic (corn stover) to ethanol pathway is also defined using data obtained using ASPEN plus. Is there any pilot or field data that can be used here to support the findings in the model? Also, is this the only Tier 2 pathway that has emerged in recent years? The report makes it seem like this may be the case.

Page 7. How do the emissions results from the MOVES model compare to those from the MOBILE6.2 model and the CARB EMFAC model? What prompted the switch other than the fact that the MOVES data is more current?

Page 8. How is uncertainty propagated through the series of models? I understand how uncertainty is handled in CA-GREET and in GTAP. In the context of the WTW calculations on page 8, does the aggregate carbon intensity value have a reliable uncertainty range associated with it?

Page 10. The language around the indirect accounting mechanisms as they relate to Tier 1 and Tier 2 fuels is a bit unclear. As written, the report states that the source must be directly consumed in the production process. But this is ambiguous in certain contexts such as those fuels that produce co-products. For example, if a corn feedstock were used to make ethanol and the stover were also used to make fuel (but was not consumed in the same production process) would that not trigger a switch from Tier 1 to Tier 2? It seems like it should but as written it might not. Clarifying this language is key for groups seeking to obtain co-product credit through the CA-LCFS.

Page 15. The difference between pathway CNG020 and CNG021 is not clear.

The OPGEE model goes into great detail cataloging the carbon intensity of different crude oils and the results are fascinating. But in light of the significant debate regarding iLUC, there is a big difference between the resolution of data for crude and for agricultural products. The report describes efforts to calculate this using AEZ and this is a strength of the approach. But I wonder whether CA-GREET is able to provide estimates at the same resolution for crop-based biofuel feedstocks coming from different regions of the US and the world? Does the model account for the same crop in difference between rain

fed and irrigated crops? How does the natural land use cover impact the emissions? What about amount of time the land has been in production? The staff should consider the resolution of the data across these modeling platforms to ensure that they are comparable.

To what extent do the CI values from the different crude sources vary year to year?

The modeling efforts include “elasticity of crop yields with respect to area of expansion”. Does it include changes to yield associated with improved technology and year-to-year variability that can come from things like the massive drought in the Midwest?

Crude Oil Carbon Intensity

How is enhanced oil recovery handled in the OPGEE model and would efforts to develop innovative EOR technologies that sequestered carbon qualify the resulting crude as an innovative pathway?

I don't know where CARB stands now wrt CO₂ EOR but if there is interest in developing a mechanism for oil producers to gain credit for producing lower CI crude through the LCFS (presumably from outside CA since very little EOR takes place in the state right now I believe), then I strongly encourage CARB to develop a mechanism to track the original source of the CO₂. Most of the CO₂ used in EOR in Texas comes from geologic formations where the carbon capture and sequestration benefits are non-existent.

The EPA Greenhouse Gas Reporting Program has been collecting data on emissions factors at the facility scale for several years. How do these self-reported emissions from EPA compare to the emissions factors from OPGEE?

How do significant price swings in crude oil prices (like the drop in prices observed over the past 6 months or a hypothetical spike in prices like the one that occurred in 2008) impact the composition of crude flowing to CA refineries? Are these fluctuations reflected in the CI calculations over such a short timestep? I recognize that this is partially an economic question and that it is therefore somewhat outside the scope of this analysis, but it seems reasonable to ask how the signals might impact the blend, which would impact the CI of the fossil transportation fuels being sold in the state. The report explains the 2010 baseline and how that will be used to lower the compliance target, but I am curious about extraneous market factors that could make meeting those targets unrelated to actual emissions reductions.

Indirect Land Use Change

This report describes the process by which the staff completed 30 scenarios and averaged the results. Were the scenarios all set up so that they would be equally likely? Additional text here would be useful.

The GTAP baseline is 2004 but that occurred before the major growth in corn ethanol production in the United States. I understand this has to do with the availability of economic databases. Are there efforts to update the model using more recent economic data? Is there an expectation that new data will provide different estimates based on changes in the biofuels landscape?

The report does not provide the actual value of the iLUC contribution that CARB is using but I found it online (30 g/MJ) and also learned that there is some disagreement in the community about which value is the most appropriate (and even whether iLUC as a mechanism is the most appropriate to capture the effect of biofuels expansion). I will not weigh in here other than to say that if the intent of CA-LCFS is to be technology-neutral then selecting a value that is at the high end of the distribution will create *de facto* caps that will suppress the development of certain fuels/pathways in the CA market.