ICCT submits this memo to Washington State Department of Ecology (ECY) based on our review of the public comments submitted to ECY by POET.[1] ICCT's peer review of the indirect land-use change (ILUC) recommendations developed by Life Cycle Associates (LC Associates) for the Clean Fuels Program (CFP) focused on the decision to cite a separate analysis for ILUC attributable corn ethanol than the set of ILUC emission factors previously assessed and utilized by the California Air Resources Board (CARB) for the California Low-Carbon Fuel Standard (LCFS). We assessed the justifications used to choose this different value, as well as the methodological differences that underpin the post-CARB analyses to evaluate whether or not LC Associates' recommendation was sufficiently justified by post-2015 scientific studies and model improvements.

Overall, ICCT found that though the CARB ILUC assessment is older than more recent ILUC studies, the ILUC assessment was conducted by a regulatory body with a high level of expert review and stakeholder input; consequently, the assumptions and model inputs therefore are more closely aligned with ground-truthed scientific data. Several subsequent analyses, including the one cited by LC Associates, have not been held to the same level of scrutiny, and indeed ICCT's peer review notes several areas where updates to the model may be inconsistent with data on land-use and soil carbon stock change.

ICCT's peer review references a variety of recent analyses to develop its recommendations. We provide additional responses to respond to the following points brought up by POET:

1. **Overall Decline in ILUC Estimates.** The comments from Poet suggest that ILUC emissions estimates have declined over time, reflecting model improvements. However, the information presented in the public comments reflects cherry picking and only presents a subset of the total analysis of the topic. Estimates of ILUC can vary considerably depending on the assessment method, model choice, and scenario design. Most recently, a 2019 analysis developed by the International Civil Aviation Organization (ICAO) estimated an ILUC value of approximately 25.1 gCO2e/MJ for corn ethanol-to-jet.[2] Notably, that analysis used two separate ILUC models and found that there could be great variation between the models depending on feedstock, as well as due to

[1] https://scs-public.s3-us-gov-west-1.amazonaws.com/env_production/oid100/did1008/pid_202037/assets/merged/rb01iqv_document.pdf?v=PN8S95VGD

[2] Estimated on a 25-year time horizon. This is equivalent to approximately 20.9 gCO2e/MJ on the 30-year time horizon used by CARB and EPA for US ILUC analyses

assumptions on yield response and foregone sequestration.[3]

A review of land-use change emissions estimates presented at EPA's 2022 Biofuel Modeling Workshop suggests that there remains substantial variation in ILUC estimates based on assessment method, feedstock, and model design, as shown below in Figure 1.[4] A summary of analyses suggests that there remains substantial variation within and across methods. Uncertainty has been driven by lack of consensus on key model inputs, such as yield improvement, land categorization, and treatment of soil carbon stock change. For example, two of the ILUC results for corn ethanol cited in the POET comment, Laborde (2010) and Valin (2015), are superficially similar at only 2 gCO_2e/MJ apart, yet the latter study estimates a 10x larger net land conversion than the other, and on a different continent.[5]

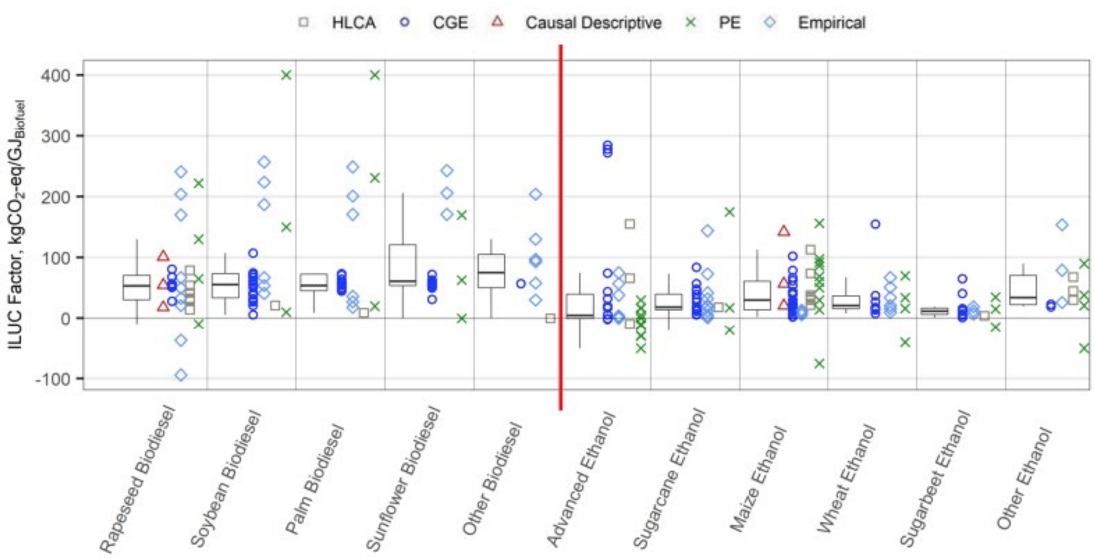

Figure 1: The ILUC factors for biodiesel and ethanol as reported in 31 quantitative studies.

Factors shown for different feedstocks and assessment methods. Boxplots indicate the mean and inter-quartile range. Whiskers extend no further than 1.5 times the inter-quartile range or the minimum (lower) or maximum (upper) values. All factors assume a harmonized amortization period of 20 years.

Source: Daioglou et al. (2020).[6]

2. **Choice of Agro-Economic Model.** The commenters argue that GTAP has a "distinguishing advantage" due to its ability to account for linkages of the biofuel industry with other economic activities on a global scale. Notably, though the

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[4] Daioglou, Vassilis. "Review of Land Use Change Estimates" Presented at EPA Biofuel Modeling Workshop, March 1st, 2022. https://www.epa.gov/renewable-fuel-standard-program/workshop-biofuel-greenhouse-gas-modeling
[5] Ibid.
[6] Daioglou, Vassilis, Geert Woltjer, Bart Strengers, Berien Elbersen, Goizeder Barberena Ibañez, David Sánchez Gonzalez, Javier Gil Barno, and Detlef P. Vuuren. "Progress and Barriers in Understanding and Preventing Indirect Land-use Change." *Biofuels, Bioproducts and Biorefining* 14, no. 5 (September 2020): 924–34. https://doi.org/10.1002/bbb.2124.

commenters cite EPA's claim that "GTAP has rapidly become a common 'language' for many of those conducting global economic analysis", EPA decided against using the model for its ILUC assessment for the RFS, opting for a combination of the FAPRI and FASOM models. Other model frameworks are also capable of assessing the land-use impacts of biofuel demand; in particular, agriculture sector partial equilibrium models such as GCAM GLOBIOM may be able to assess the agriculture sector in more detail than CGE models, as they contain more granular detail. Ultimately, we note that scenario design and model inputs may be as impactful as the choice of model.

3. **Soil Carbon Stock Change.** A key point in ICCT's peer review is that the modeled net-negative soil carbon stock change for converting cropland-pasture to cropland in the CCLUB model is not backed by real-world data. We cite a meta-analysis of 74 studies that finds that the conversion of pastureland to cropland reduces soil carbon stocks for that land by approximately 60%, rather than increasing them.[7] In contrast, CCLUB estimates that this conversion will sequester carbon. Though the commenters claim that the emissions from converting cropland-pasture to cropland will be lower, they do not provide evidence that the emissions will be negative. The AEZ-EF assumption that cropland-pastureland conversion has a lower impact than "permanent" pastureland conversion is consistent with the commenters' claim.
4. **Classification of Cropland-Pasture.** The commenters argue that the peer review challenges the classification of cropland-pasture in GTAP due to model updates that include adjusted land transformation elasticities. In fact, this is a misunderstanding of ICCT's criticism of the cropland-pasture category. Our peer review notes a mismatch between the classification of the land category within the land database in the model and the land conversion emission factor it is assigned.

   We reiterate that the official definition of cropland-pasture in the United States Department of Agriculture's glossary is: "Cropland pasture—Generally is considered to be in long-term crop rotation." However, the CENTURY soil carbon stock values used in CCLUB are derived assuming cropland-pasture was in a cropped state for 35 years prior to conversion to corn production.[8] It is therefore likely that any cropland-pasture soil carbon in the CENTURY model will have had carbon stocks depleted by 35 years of continuous cropping. In contrast, recently-converted pastureland (similar to USDA's definition), would have higher carbon stocks. For land that is cycling between cropland and pastureland in recent years, the AEZ-EF approach of a soil carbon change emission factor halfway between pastureland and cropland would more closely reflect the data on soil carbon stock change than the current approach, which estimates net carbon sequestration when cropland expands onto this land category.
5. **Unmanaged Forestland.** The commenters argue that the current treatment of unmanaged forestland in GTAP-BIO is sufficient due to the classification of forestland as

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[7] L. B. Guo and R. M. Gifford, "Soil Carbon Stocks and Land Use Change: A Meta Analysis: SOIL CARBON STOCKS and LAND USE CHANGE," Global Change Biology 8, no. 4 (April 2002): 345–60, https://doi.org/10.1046/j.1354-1013.2002.00486.x.

[8] The CENTURY model assumes that cropland-pasture was pasture before 1880, then cropped from 1880 to 1950, pasture again from 1951 to 1975, and then cropping from 1976 to 2010

accessible vs. inaccessible. However, we note that in the underlying study cited in the peer review directly addresses this point. Plevin et al. (2022) argues that classifying land as “inaccessible” based on its proximity to roads per FAO's assessment in the year 2000 likely underestimates accessibility today and in the coming decades over the modeled time horizon.[9] The authors note that since that FAO assessment, countries with previously inaccessible forests have greatly expanded their road infrastructure while deforestation has continued. The study summarizes the recent literature on non-commercial forest loss in the last 20 years to justify its comparison of forest classification between the GCAM and GTAP-BIO models.

6. **Yield Response and Double-Cropping.** YDEL in GTAP modeling reflects the yield increase in biofuel in response to price increases. The commenters argue separately that a YDEL (yield response elasticity) of 0.25 is justified based on expert consensus, and further, that a separate multi-cropping modification to GTAP-BIO helped to improved alignment between model estimates and empirical data on crop extensification. This comment does not respond to the key points made by the Peer Review, and in fact the commenters write that “Our review of the state of the science thus shows that a YDEL of 0.25 is appropriate and lower than the high end of the current most credible range”. The commenters review of the literature suggest an average YDEL value of 0.23. We emphasize that the YDEL value of 0.25 was agreed upon by the CARB expert working group. Though it was higher than some estimates, the final was agreed upon based on an assumption that it included multi-cropping, and that a YDEL of 0.25 was used in the corn ILUC value that was developed by CARB that ICCT recommends for WA ECY.

   A key point in the ICCT peer review is that the YDEL of 0.25 used by CARB was then revised upwards in subsequent revisions to GTAP-BIO, to a high of 0.325 for major biofuel-producing regions. The U.S. YDEL was also increased to 0.325, despite the authors claim that the original 0.25 which is described by Taheripour et al. (2017) as “supported by the literature” is based on analysis of U.S. data only.[10] On top of this increase, a separate land intensification parameter was added to GTAP-BIO to model multi-cropping, which had previously been implicit in the YDEL. By adding this on top of the higher YDEL of 0.325, subsequent revisions to GTAP have potentially double-counted the impact of multi-cropping and likely greatly reduced the modeled impact of ILUC.
7. **Definition of Cover Cropping.** Several comments received by ECY suggest that there is uncertainty over the definition of cover crops and how to attribute ILUC to them. We note that multi-cropping is already practiced in some regions in the absence of policies to promote cover cropping, and these secondary crops are already well-integrated into food and feed markets. Multi-cropping is also factored into ILUC assessments. The EU has proposed that demand for cover crops does not trigger demand for additional

[9] Richard J. Plevin et al., “Choices in Land Representation Materially Affect Modeled Biofuel Carbon Intensity Estimates,” Journal of Cleaner Production 349 (May 2022): 131477, https://doi.org/10.1016/j.jclepro.2022.131477.
[10] Richard Plevin, and Robert Edwards, “How Robust Are Reductions in Modeled Estimates from GTAP-BIO of the Indirect Land Use Change Induced by Conventional Biofuels?,” Journal of Cleaner Production 258 (June 10, 2020): 120716, https://doi.org/10.1016/j.jclepro.2020.120716

land.[11]

We propose the following definitions:

a. **Primary crop**: the first cash crop harvested in the agricultural year
b. (i.e. harvested after the winter)
c. **Multi-cropping:** an agricultural rotation that includes a first and second cash crop, and may also include one or more cover crops.
d. **Cover crop:** a crop grown primarily for the purpose of maintaining or enhancing the productivity of the land, often present in the field over the less productive part of the year (this is generally the winter, but in tropical locations may be associated with a dry season in a different part of the year). The use of such intermediate crops does not trigger demand for additional land.

[11] https://theicct.org/sites/default/files/publications/intermediate-crops-RED-II-eu-oct21.pdf