

Treatment of Land Use Change in the CHS

Question Presented

How should land use change be considered, if at all, in the liquid biofuel lifecycle carbon intensity (CI) scores?

- Option 1: Exclude LUC (OD proposed approach)
- Option 2: Include LUC

Opinion Dynamics (OD) Proposed Approach¹

- Assume there is no change in land use (either direct or indirect) associated with the biofuel that needs to be quantified in the emission rates
- Land use change (LUC)² from the CI scores and targets excluded for a number of reasons^{3,4}:
 - GREET1 2023 is inconsistent in accounting of land use changes in fuel production and feedstock
 - Simplified assumptions allow for a TRM that is an easy-to-use, replicable and transparent resource
 - Crop-based biofuels⁵ are currently produced predominately in the Midwest; they are assumed to be grown on dedicated land for explicit use in the energy sector, among their other uses (e.g., protein for animal feed)

¹ Draft Vermont Clean Heat Standard Lifecycle Emissions Rate Schedule, Aug. 29, 2024, at 7; OD Memo Response to Sept. 17, 2024, TAG Questions, Oct. 2, 2024, at 2.

² Note: ILUC modeling represents both direct and indirect LUC as an output – it's really induced land use change. The models cannot separate the two. Thus, for this discussion, we will refer to them collectively simply as "LUC."

³ Draft CHS Emissions Rate Schedule, op cit. at 7:

"For biofuels developed from purpose grown crops and animal waste, our emissions analysis assumes that there is no change in land use associated with the biofuel that needs to be quantified in our emissions rates.

- Biofuels from purpose grown crops are currently predominately produced in the Midwestern United States. In our analysis, we assume that feedstock crops, such as soybeans, corn and canola, are grown on dedicated land for explicit use in the energy sector. This simplification, along with the uncertainty around the change in demand for these fuels nationally, and Vermont's contribution to that demand, leads to our decision to not quantify the implications of land use change on upstream emissions.
- For biofuels from animal waste, our analysis assumes no change in land use as the feedstock is a byproduct and not the primary driver for animal farms."

⁴ OD 10/2/24 response to the TAG's 9/17/24 questions at p. 2:

"As we worked within GREET to account for LUCs, we determined that GREET is inconsistent how these impacts are accounted. For example, LUC impacts associated with soybeans include explicit input parameters, while other crop-based feedstocks do not. This resulted in additional challenges for proper accounting on top of issues like additionality. Lastly, our aim with the CHS is to produce a replicable and transparent resource that is easy to use. To achieve this, we made assumptions and simplifications to ensure that future revisions could replicate our numbers while also advancing its content. We appreciate the TAG's comments on LUCs; we don't believe that it is inappropriate to include LUCs, but at this time we don't see a pathway to including them in our carbon intensity values."

⁵ OD's characterization of soybean and canola as "purpose grown" crops is factually inaccurate as it implies these crops are grown specifically for their oil content to be used for biofuel production. However, all biofuel crops

- Uncertainty around change in demand for these fuels nationally and Vermont's contribution to that demand

Statutory Requirements

- **Express References to “land use change”:** Act 18 mentions “land use change” twice:
 - 30 V.S.A. § 8128(a)(3) includes the following as one of the duties of the Technical Advisory Group (TAG): “periodically assessing and reporting to the [PUC] on the sustainability of the production of clean heat measures by considering factors including greenhouse gas emissions; carbon sequestration and storage; human health impacts; land use changes; ecological and biodiversity impacts; groundwater and surface water impacts; air, water, and soil pollution; and impacts on food costs.” [emphasis added]
 - 30 V.S.A. § 8128(b) specifies a number of fields of expertise that should be represented among the TAG members selected by the PUC; these enumerated fields include expertise in “land use change” among the many fields identified.
- **Implied Reference to “land use change”:**
 - **30 V.S.A. § 8127(h)** (“Review of Consequences”) directs the PUC to “biennially assess harmful consequences that may arise in Vermont or elsewhere from the implementation of specific types of clean heat measures and shall set standards or limits to prevent those consequences. Such consequences shall include environmental burdens as defined in 3 V.S.A. § 6002, public health, deforestation or forest degradation, conversion of grasslands, increased emissions of criteria pollutants, damage to watersheds, or the creation of new methane to meet fuel demand.”
- **References to “verifiable” and “measured”:**
 - 30 V.S.A. § 8127(c) requires that “[c]lean heat credits . . . be based on the accurate and verifiable lifecycle CO₂e emission reductions in Vermont’s thermal sector . . .” [emphasis added]
 - 30 V.S.A. § 8127(g)(1) requires that the emissions schedule “be based on transparent, verifiable, and accurate emissions accounting adapting . . . GREET . . . or an alternative of comparable rigor to fit the Vermont thermal sector context, and the requirements of 10 V.S.A. § 578(a)(2) and (3).” [emphasis added]
 - **30 V.S.A. § 8127(f)(3)** requires that “[c]arbon intensity values shall be measured based on fuel pathways. [emphasis added]
- **References to “fuel pathway”:**
 - 30 V.S.A. § 8127(f)(3) requires that, for purposes of this section, CI scores “be measured based on fuel pathways” and “fuel pathway” is defined in 30 V.S.A. § 8123(10) to include “feedstock generation.”

generate a variety of fuel and non-fuel products. For example, 80% of the biomass in soybeans is protein, which is used in animal feed and other protein applications. Only 20% of the bean mass is oil, and only a fraction of that oil is converted to biofuel. The remaining oil is used for industrial, commercial, and personal care products, along with a host of other applications.

- 30 V.S.A. § 8127(g)(2) requires that the emissions schedule, for each fuel pathway, account for, among other things, the “loss of stored carbon.”

Support for Option 1 (Exclude LUC)

As a starting point, indirect or induced LUC (ILUC) is based on the theory that land outside of the U.S. not already in use for biofuel production will be converted for agricultural purposes to backfill for the biomass converted into biofuel feedstock in the U.S. By definition, ILUC cannot be directly measured, but must be inferred from computer models that attempt to simulate global market responses to an external factor such as a major policy shift in one or more jurisdictions.

- *No explicit statutory requirement for upfront LUC incorporation.* As noted above, there is nothing in Act 18 that explicitly requires the CHS to incorporate a land use component to a fuel’s lifecycle CI score. Indeed, the wording in Section 8128(a)(3) suggests the Legislature intended land use change to be considered retrospectively as part of the TAG’s ongoing duties after the CHS is adopted (i.e., assisting the PUC with “ongoing management of the CHS,” including “periodically assessing and reporting...on the sustainability [of clean heat measures]”). This ongoing assessment includes looking at a variety of factors, with land use change being just one of many different factors identified, for potential impacts on the sustainability of clean heat measures being implemented. This “look back” intent is reinforced by Section 8127(h) [“Review of Consequences”], which directs the PUC to assess every two years the potential consequences of a clean heat measure, including but not limited to “deforestation or forest degradation” and “conversion of grasslands,” two typical types of land use change.
- *OD correctly identified sound and reasonable bases for excluding LUC.* As OD stated, LUC treatment (both direct LUC and indirect LUC) is inconsistent within the GREET model. Making the inputs and assumptions consistent among the various biofuels currently in or expected to be available to the region will require substantial additional expenditure of public resources for little or no gain:
 - ILUC modeling typically costs in the tens to hundreds of thousands of dollars, depending on the analyses requested. It requires specialized expertise in agroecconomics and is typically done by experienced academic institutions
 - ILUC modeling is highly uncertain, controversial, heavily dependent on the inputs and assumptions used as well as the expertise of the modeler in interpreting the data, and by its nature, cannot be verified in the real world.⁶
 - Nevertheless, the trend shows that as researchers have refined ILUC models to incorporate more nuance and understanding of agricultural and fuel markets, the

⁶ To illustrate, ILUC does not represent modeled changes in land use but a predetermined volume of increased biofuel production’s hypothetical impact on the rate of afforestation and/or deforestation. E.g., Empirical ILUC modeling results show acres of cropland conversion in U.S. domestic models considering LUC impacts of the EPA’s Renewable Fuel Standard, but U.S. cropland has not increased during the entire life of the policy.

resulting impacts have continuously declined. ILUC estimates for soybean oil have been reduced by over 95% since the initial estimates of soy ILUC at 300+ g/CO₂e/MJ (early 2000s) to the current 2023 estimate by Purdue University, developer of the widely used Global Trade Analysis Project (GTAP) ILUC model. Purdue estimated an ILUC of about 9.1-9.7 g CO₂e/MJ, estimated for a California-scale volume shock (3.22 billion gallons).⁷ By contrast, the current CARB (2015) estimate for soy ILUC is 29.1 gCO₂e/MJ, based on outdated data that is twenty years old and on a shock volume of 812 million gallons, whereas the most recent Purdue estimate (using the same GTAP model but updated with more recent data) shows 1/3 of the current CARB estimate (9.7 gCO₂e/MJ) at four times the shock volume CARB used (3.22 billion gallons vs. 812 million gallons)

- The crops from which a small percentage of lipids would be used for this program are already grown sustainably on land that was in productive use before 2008 (a requirement for fuels to receive credit under the federal Renewable Fuel Standard). Therefore, no deforestation or other adverse change in land use would be expected to result from production of crop-based biofuels to meet the CHS requirements; the U.S. and Canada can easily absorb Vermont's demand for biofuel feedstock without converting additional acreage.
- Total U.S. consumption of biodiesel, renewable diesel, and renewable heating oil was 4.6-4.8 billion gallons in 2023.⁸ Less than half that amount (48.3% by weight) was produced from soybean oil and canola oil, or about 2.2-2.3 billion⁹ gallons of crop-based biodiesel and renewable diesel sustainably grown on land designated for this use since 2008.
- Vermont's heating oil consumption in the residential and commercial sectors was about 102 million gallons in 2020.¹⁰ GTAP modeling of the ILUC that might occur from a policy like the CHS affecting such a small fraction of the overall U.S. consumption might be technically feasible, but it would be an expensive exercise that would most likely result in meaningless numbers, essentially within the "noise"
- *Inclusion of ILUC conflicts with Section 8127.* Since ILUC is, by definition, not directly measurable, it is inherently unverifiable. Therefore, including it in the CI scores would conflict with Section 8127's requirement for verifiability.

Support for Option 2 (Include LUC)

- *Statutory requirement that clean heat measures be evaluated based on fuel pathway, which includes feedstock generation, and loss of stored carbon.* As noted above, Act 18 explicitly requires that the CI account for the specific fuel pathway, which includes feedstock

⁷ Purdue University analysis, June 2023

⁸ Energy Information Administration, EPA Moderated Transaction System (EMTS)

⁹ Ibid

¹⁰ EIA, https://www.eia.gov/dnav/pet/PET_CONS_821USE_DCU_SVT_A.htm, visited 10/8/2024

generation. It is incomplete to evaluate a biofuel without also including how land would be used but for the feedstock generation.

- *OD noted that it is **not inappropriate** to include LUC emissions, while also noting the added complexities.* As can be seen from other jurisdictions, like with the California Air Resources Board's (CARB) Low Carbon Fuel Standard (LCFS), just because there is inconsistent treatment of LUC emissions in GREET and other challenges does not mean that it is not more complete to include LUC emissions.¹¹ OD opted to make certain assumptions and simplifications, but an option could be to use the accounting that has already been done by CARB for the LCFS to create default LUC emissions for use in determining CI scores.¹² It's also worth noting that the question of LUC impacts has been extensively discussed in the US EPA Renewable Fuel Standard. EPA includes LUC impacts for its national policies and has done extensive work to analyze the state of the literature. Excluding LUC would be inconsistent with the approach taken by US EPA, which has put more time into this question than any other agency in the US.
- *Inclusion of LUC emissions is consistent with statutory requirements that CI scores be based on verifiable lifecycle CO2 emissions.* Looking to other jurisdictions, such as CARB and the LCFS, it is common to require that greenhouse gas emissions reductions be "verifiable" even though it is technically preferred to refer to the separate components of "verification" and "validation."¹³ Validation, as opposed to verification, needs to be used when there is not observable evidence that substantiates a claim (such as with a counterfactual of LUC emissions). Including LUC emissions in CI scores in Vermont, even when those CI scores need to be verified (but not explicitly validated), would be consistent with the approach that has been taken in other jurisdictions, such as with the LCFS.¹⁴
- *Other jurisdictions are considering increasing the LUC emissions that are incorporated into CI scores.* Despite the complexity of LUC emissions, other regulatory bodies, such as CARB, are considering increasing LUC emissions and giving greater flexibility to increase the LUC emissions that are factored into a CI score in certain situations.¹⁵

¹¹ See [LCFS Regulation § 95488.3 Table 6](#) (Table 6) (includes LUC values for use in CI determination and cited authorities), visited 10/9/2024.

¹² See [id.](#)

¹³ See CAL. HEALTH & SAFETY CODE § 38562(d)(1) (2017); International Organization for Standardization (ISO) 14064-3:2019 (Specification with guidance for the verification and validation of greenhouse gas statements).

¹⁴ See Table 6.

¹⁵ See [Proposed Amendments to the LCFS Regulation, Aug. 12, 2024, at p. 128](#) ("The Executive Officer may determine that no value in Table 6 is conservatively representative and assign a more conservative [(higher)] LUC value."), visited 10/9/24.