The Role of Modeling Given Uncertainty

Nikita Pavlenko
Fuel Program Lead, International Council on Clean Transportation
EPA Workshop on Biofuel GHG Modeling, March 1st 2022
Sources of Uncertainty in Biofuel LCA
Types of Uncertainty

- Uncertainty is inherent within modeling for both direct and indirect LCA
  - **Aleatory Uncertainty**—Inherent randomness of a system
  - **Epistemic Uncertainty**—Data and knowledge gaps
- LCA guidance (ISO 14040) recommends sensitivity analysis to evaluate the robustness of the results
Uncertainty in Direct LCA

- Most LCA relies on a mix of collected LCI data and assumptions + modeled data
- Subject to year-to-year & regional variation
- Data gaps may require assumptions for parameters

Crop Production
- Fertilizer application
- Yield
- \( \text{N}_2\text{O} \) Emissions
- Chemical application
- Fossil fuel input
- SOC Change
  - Distribution distance
  - Distribution mode

Logistics
- Distribution distance
- Distribution mode

Fuel Production
- Yield
- Co-product displacement
- Fossil fuel input
  - Distribution distance
  - Distribution mode

Fuel Distribution

Adapted from Liska, 2015
Uncertainty in Direct LCA

- Sensitivity analysis identifies which parameters & assumptions have largest impact on results
- Identify impacts of decisions on allocation
- Can be used to inform further research & data collection
- Can inform the likely range of outcomes

Adapted from Scully et al., 2021
Uncertainty in ILUC

- Greater reliance on modeling and assumptions than direct LCA
- Extremely sensitive to parameters & assumptions (i.e., decision uncertainty)
- Impacted by model choice, scenario design, analytical scope

Adapted from ICAO CORSIA LCA Methodology, 2019
Uncertainty in ILUC

- Greater reliance on modeling and assumptions than direct LCA
- Extremely sensitive to parameters & assumptions (i.e., decision uncertainty)
- Impacted by model choice, scenario design, analytical scope

GLOBIOM ILUC Sensitivity Analysis; Adapted from ICAO CORSIA LCA Methodology, 2019
Beyond Existing Models

- Effects outside scope of many existing models
- Displacement & substitution effects
- Rebound effects
- These effects are often tied to behavioral assumptions (e.g., demand response)

Adapted from O’Malley et al., 2021
Making Sense of Uncertain Results

- Decide what range of outcomes is acceptable for policy (i.e., an uncertainty standard)
- Evaluate the range of results for a given pathway
  - Assess sensitivity analyses; identify key sources of parametric uncertainty & data needs
  - Where possible, compare trends across different models (e.g., ICAO CORSIA process)
  - Assess the risk of indirect effects outside of existing models
Using Modeling Results to Inform Biofuel Policy
LCFS-Style GHG Accounting

- Inherent assumption of precision; policy value associated with incremental GHG reductions
- Greater reliance on collected data; site-specific inputs
- Typically combines direct, site-specific LCA factors with a single ILUC emission factor
GHG Reduction thresholds

- Lower threshold implies greater certainty of modeling results
- Higher threshold may exclude some low-CI pathways, in exchange for greater certainty

<table>
<thead>
<tr>
<th>Policy</th>
<th>GHG Reduction Threshold</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICAO CORSIA</td>
<td>10%</td>
<td>Direct + Indirect</td>
</tr>
<tr>
<td>US RFS2</td>
<td>20%-60% by category</td>
<td>Direct + Indirect</td>
</tr>
<tr>
<td>EU RED II</td>
<td>50-65% by facility date</td>
<td>Direct only</td>
</tr>
</tbody>
</table>
Other Eligibility Requirements

• “High-ILUC” risk exclusions (EU RED II, proposed Canada Clean Fuel Standard)
• Regulatory impact assessment may be used to assess consequential effects and identify high-risk pathways
• Based on trends identified in modeling, not necessarily specific LCA values
Concluding Remarks

• LCA models provide valuable information, but are not necessarily definitive
• Identifying trends and risk areas just as important to LCA as specific emissions estimates
• Policy design can incentivize biofuels with greater certainty of GHG reductions
Questions?
Contact Nik at n.pavlenko@theicct.org