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National Academies of Sciences Report on Current Methods for Life-Cycle Analyses of Low-Carbon Transportation Fuels

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Disclaimer

This presentation contains selected excerpts from the Committee Report. Interested parties should read the report in its completeness.

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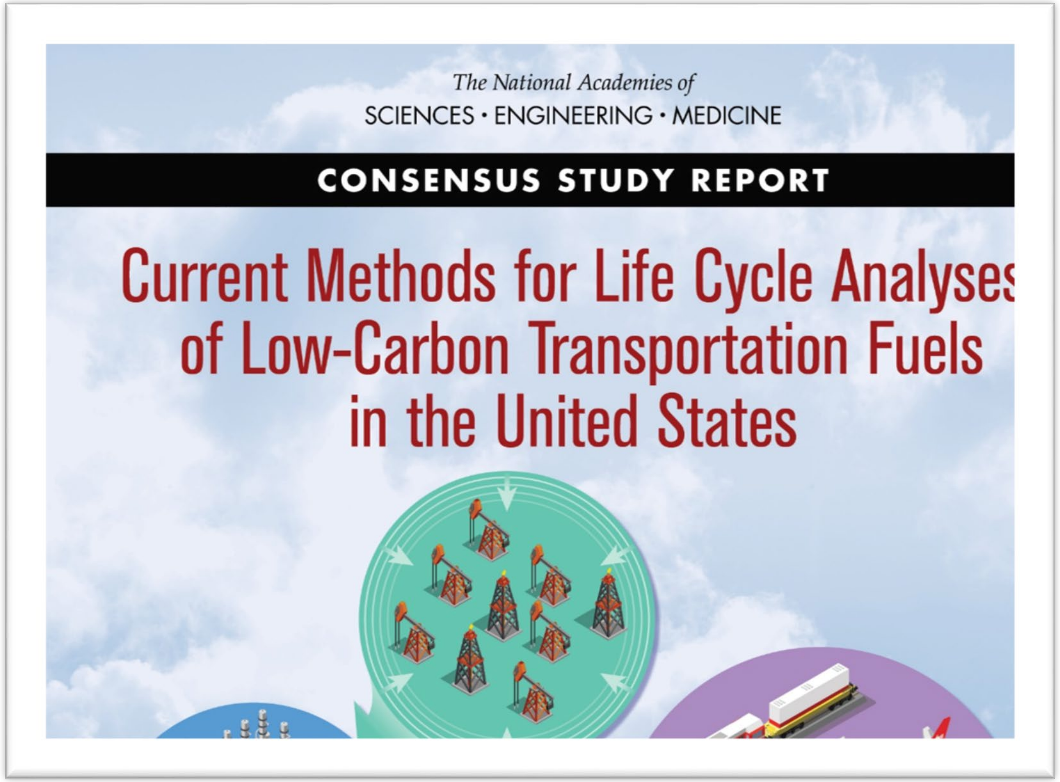

Selected Insights

Amortization

Verification

Symmetric Scrutiny

Fuel Octane

Electric Vehicles

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10 Chapters: Table of Contents

1) INTRODUCTION AND POLICY CONTEXT
2) FUNDAMENTALS OF LIFE-CYCLE ASSESSMENT
3) LIFE-CYCLE ASSESSMENT IN A LOW-CARBON FUEL STANDARD POLICY
4) KEY CONSIDERATIONS: DIRECT AND INDIRECT EFFECTS, UNCERTAINTY VARIABILITY, AND SCALE OF PRODUCTION
5) VERIFICATION
6) SPECIFIC METHODOLOGICAL ISSUES RELEVANT TO A LOW-CARBON FUEL STANDARD
7) FOSSIL AND GASEOUS FUELS FOR ROAD TRANSPORTATION
8) AVIATION AND MARITIME FUELS
9) BIOFUELS
10) ELECTRICITY AS A VEHICLE FUEL

Chapter 4

KEY CONSIDERATIONS: DIRECT AND INDIRECT EFFECTS, UNCERTAINTY VARIABILITY, AND SCALE OF PRODUCTION

Chapter 4: Direct and Indirect Effects

TABLE 4.3 Examples of Factors Often Referred to as "Direct" or "Indirect" in the Transportation Fuels Literature

Direct/Indirect	Biofuel Examples	Electric Vehicle Examples
Potentially referred to as direct effects	Emissions from corn and soybeans in supply chain of an ethanol or biodiesel plant (Plevin et al., 2014a)	N/A
Potentially referred to as indirect effects	Land use emissions and sequestration effects due to changes in demand for a given feedstock: – changes in agricultural biomass, – changes in forgone sequestration, – changes in soil organic carbon, – changes of forest or grassland	Induced emissions due to changes in demand for electricity: – shift in dispatch towards marginal resources to accommodate EVs – adjustments in generation capacity expansion planning (Taheripour et al., 2017) – introduction of Time-of-Use charges and Demand-Side Management Programs (Schmidt et al., 2015). – changes in feedstock sourcing for additional baseload and intermediate electric generating resources (additional fracking, coal mining, liquefied natural gas import/export).
Potentially referred to as indirect effects due to rebound or fuel market price effects	– Higher demand for ag commodities increases or decreases feed/food prices and their consumption (Schmidt et al., 2015)	– Higher demand for electricity increases or decreases electric rates to consumers, affecting other demand and generation or – Installed capacity costs decrease ($/kW) due to economies of scale

This is where I emphasize Symmetric Scrutiny

Chapter 4: Direct and Indirect Effects

	– Yield improvement due to additional investment in agricultural activities induced by biofuel production – Yield reduction due to marginal land being brought into production – Reduced gasoline or diesel consumption results in decline in price and an increase in use elsewhere (Martin, 2013)	resulting in other electricity uses (electric heating, water heating) – Lower vehicle operating costs result in increased travel, reduced range results in reduced travel, or higher upfront costs affect household spending on other items with GHG implications – Reduced gasoline demand results in decline in price and an increase in use elsewhere.

Amortization Period

Variation Due to the Choice of Amortization Time Period

- The choice of amortization time horizon directly affects the size of ILUC values.
- While the Intergovernmental Panel on Climate Change (IPCC) approach can be followed to evaluate ILUC values based on the Global Warming Potential (GWP) index over a 100-year time horizon (Schmidt et al., 2015), a second time horizon pertains to the assumed duration of a biofuels policy.
- Some existing ILUC practices simply amortize induced land use emissions due to a biofuels volume over the number of years the biofuels policy is presumed to be in effect.
- Some studies have used 20 years other studies have used 30 years for the time horizon following U.S regulatory emissions guidelines. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA, 2021), which represents an international scheme for offsetting and emissions reduction, has applied a 25-year time horizon, a compromise between the U.S. and EU time horizons. Some studies have adopted a 100-year time horizon approach.
- However, the choice of the amortization periods in ILUC modeling may be a political decision and subject to the time period for policy goals.

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Chapter 4: Amortization Period

- There is no single correct choice for amortization period. Schmidt et al. (2015) state: “Applying an amortization period, however, introduces arbitrary assumptions, inconsistencies and strange cause-effect relationships (Schmidt et al., 2015).”
- One potential alternative is “Baseline Time Accounting” which derives ILUC values independent of amortization periods but takes into account global land use dynamics and the fact that land used for biofuels production can return to food production (Kløverpris and Mueller, 2013; Schmidt et al., 2015).
    - This committee neither endorses nor discourages this alternative.
    - While the approach has received support and criticism, it raises the point that what happens to the land after a policy ends may matter (Kløverpris and Mueller, 2014; Martin, 2013).
    - Baseline Time Accounting also uses assumptions, such as in the determination of counterfactual scenarios.
    - For example, with the electrification of the ground and aviation sectors much smaller land use changes are expected than for biofuels policies, but the land use changes for transmission lines, power plants, and rare earth metal mining may not allow food/feed production after the policy ends.

Chapter 5

VERIFICATION

Verification: iLUC

- Market mediated effects
  - e.g. International Land Use Change
  - e.g. Marginal Grid Resourcs
- Supply Chain Verification

Verification of Market Mediated Effects: International Land Use Change

Recommendation 5-2: The research and policy communities should develop frameworks and methodologies for use of satellite data to characterize national and international land use change that may be in part attributable to an LCFS.

Examples of framing questions include:

- Should an **LCFS include measures to mitigate undesirable international land use change**, or is it sufficient to monitor international land use change that may be due to the LCFS and these GHG emissions to the associated fuel?
- What are the **guardrails (e.g., amount and type of land converted to agriculture in a certain region)** that a monitoring approach would put in place and, if approached or exceeded, what action would be undertaken as a result?
- **How can satellite data and economic modeling be most effectively used synergistically to limit GHG emissions from international land use change?**
- What public data sources will be used to track land use change?
- How should uncertainty in LUC estimates be reported?

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Verification of Market Mediated Effects: Marginal Grid Adjustments

- **Beyond land use change, other national-level market-mediated effects may be evaluated under LCFS policies.**
  - Expanded use of electric vehicles could result in incremental load additions that may put **increased pressure on the use of marginal generating resources**. One study has shown that marginal resources often result in higher carbon intensities (Ryan et al., 2016). Conversely, smart charging technologies can provide load shaping and reduce ramp rates on the power infrastructure (van Triel and Lipman, 2020).
  - Others have shown potential **stress to power grids** from electric vehicles (EVs), or result in reassignment of resources to EV charging from other loads and adjustments in electricity prices2 (Brown, 2020; Garcia and Freire, 2016; Graff Zivin et al., 2014; Vivanco et al., 2014).
  - Electricity price adjustments from **load shaping programs**, renewable portfolio standards and other measures aimed at addressing market-mediated effects associated with EVs must be carefully monitored to ensure transparency for rate payers.

Verification: Main Conclusion and Recommendation

- Recommendation 5-6: **An LCFS should consider inclusion of a certification protocol with verification.** The protocol and its implementation should be overseen by an agency or group of agencies with the complementary expertise sets needed for success.
- It should be noted that certification protocols may be carried out by private companies within rules set by public, policy-setting entities (e.g., co-regulation). In a regulatory context, the term coregulation (German Federal Ministry for Economy Cooperation and Development, 2013) indicates that regulators have defined sustainability criteria for certain economic sectors or activities and recognize verification processes carried out by private sector auditors that ensure compliance with those criteria.
- Co-regulation via third party verification protocols needs to be adequately organized. **Verification systems should be independent, third party systems with multi-stakeholder governance (including large nongovernmental organization shares).** They should also incorporate internal integrity auditing systems. In these procedures, the certification protocol periodically audits their own recognized auditors to ensure that the protocols are followed correctly.

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Challenges in Implementing Verification Approaches

Inadvertent Favoring of Individual Fuels

Observation of CA-LCFS, which allows for individual, company-specific fuel pathways to become eligible based on their CI, has highlighted how an LCFS policy **might inadvertently or intentionally favor one fuel pathway over another**.

Such a concern has been raised about the LCFS because it awards CI credits for activities that could reduce transportation GHG emissions but are not directly tied to the process of selling low-carbon fuels themselves.

The CA-LCFS, however, currently **only applies this approach to EV-related pathways**. It **awards rebates for installing charging stations funded by selling credits generated by supplying electricity to EVs. Within the LCFS, there is no comparable incentive for infrastructure related to biofuels like e85 pump installation (Bushnell et al.,2021) or other fuels.** If using verification to award credits for non-fuel-sales related activities is inconsistent across different fuel types, the policy may not be technology-neutral.7

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Fuel Octane

- **Fuels with high octane ratings allow vehicle manufacturers to increase the compression ratio in an engine, which enables that engine to extract more mechanical energy from a given mass of air–fuel mixture due to its higher thermal efficiency.**
- This has attracted engine and emissions researchers to study and develop engines that utilize higher octane fuels (Costenoble and de Groot, 2020; DOE, 2017; Schifter et al., 2020; Storey et al., 2016; West et al., 2018; Yang et al., 2019).
- **The reviewed studies show that optimized higher octane fuel engines may at least partially or more than fully compensate for ethanol's lower volumetric fuel economy (due to its lower heating value) and result in increased energy economy ratio,** which is defined as the energy consumption in British thermal unit (joule) of the conventional E10 vehicle divided by that of the alternative fuel (Unnasch and Browning, 2000).

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Fuel Octane

Conclusion 6-8: **Specifically formulated high octane fuels in combination with dedicated fuel engine technologies can provide efficiency improvements in fuel combustion that affect LCA results.**

Recommendation 6-13: LCAs of high-octane fuels should consider the impact of fuel octane on vehicle efficiency, but for the purpose of broad policy assessment LCA should be based on the actual and anticipated vehicle fleet, and following common practice for fuel vehicle assessments include only combinations that reflect reality.