Life Cycle Impacts of Biodistillate Transportation Fuels

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Presentation Outline

- Objectives
- Policy Drivers
- Fuel LCA Overview
- Key Inputs
- Carbon Impact Studies
- Summary and Conclusions
Objectives

- Overall CRC-AVFL-17 Project: Literature study to assess the state of knowledge regarding bio-derived mid-distillate transportation fuels
  - Considered plant- and animal-derived feedstocks
  - Did not consider lignocellulosic feedstocks
  - Included biodiesel and renewable diesel

- This paper deals with life cycle impacts of biodistillates:
  - Life-cycle analyses for energy and greenhouse gases (GHG)
  - 55 studies were evaluated
Policy Drivers for GHG control

  - Biomass-based diesel: 1 billion gallons by 2012
  - Must meet a 50% lifecycle GHG threshold relative to 2005 petroleum diesel values
- California—Low Carbon Fuel Standard
  - Reduce GHG emissions to 1990 levels by 2020
  - Alternative fuels must comprise 20% on-road motor vehicle fuels by 2020
  - Reduce carbon intensity of fuels by 10% by 2020.
- Additional policy drivers in other countries

This is a rapidly evolving area!
Life Cycle Assessment of a Biofuel
Cradle to grave impacts of producing and using a fuel.

Well-to-Wheels

Well-to-Pump

Pump-to-Wheel

Crop growth & Harvest
Oil Extraction
Biodiesel Production
Biodiesel Transport
Storage
Use

Co-product production
Meal
Glycerine

Clearly defined boundaries are crucial!
Key Issues

- Nitrogen fertilizer for plant growth
- Conversion factor of nitrogen fertilizer to N\textsubscript{2}O
- Crop yields
- Farming energy and chemical requirements
- Energy use in biofuel processing plants, including the type and amount of process fuel
- Scale of production
- Credits given to co-products
- Land use changes

Dealing with Co-products

- Impacts can be shared with co-products if they have value elsewhere in the market place.
  - **Physical Allocation** — based upon a common physical parameter (mass or energy)
  - **Economic Allocation** — based upon market price
  - **Expanded Allocation** (Displacement or Substitution) — byproducts are assumed to replace existing products. Impacts from the replaced products are subtracted from the impacts of the biofuel
  - **No Co-Product Allocation** — all impacts are attributed to the final biofuel
Land Use Change

Direct Land Use Change
- Preparation of land may cause modifications to soil carbon.
- Nitrogen emissions from fertilizers (N₂O has GWP 296 times that of CO₂).
- Requires agricultural-related assumptions.
- Also called Attributional LCA.

Indirect Land Use Change
- Changes to crop land or diversion of crops may lead to increased crop production elsewhere in the world.
- May reduce virgin lands, causing significant releases of CO₂. (Carbon debt).
- Requires economic modeling.
- Also called Consequential LCA.
Life Cycle Global Warming Potential (GWP) of Biodistillate Fuels
Published results from 55 studies

GWP (g CO2 eq./MJ fuel)

Year of Publication

Numbering refers to study number detailed in SAE Paper 2009-01-2768
GWP Allocation by Category for Selected Studies

Study Number and Feedstock

Numbering refers to study number detailed in SAE Paper 2009-01-2768
Summary and Conclusions (1 of 2)

1. LCA models are critical tools to understand the benefits of biodistillate fuels compared to conventional fuels
   - Models are data intensive and specific to each case
   - The most critical model inputs have the greatest uncertainty

2. LCA modeling studies are being conducted at an increasing rate
   - Most show substantial GWP benefit compared to conventional fuels (around 45-85%)
   - Most show substantial energy return benefit compared to conventional fuels (typically 3-5 times improvement)
   - Large variability in results from one study to the next.
Summary and Conclusions (2 of 2)

3. Policy and regulations are requiring more extensive use of LCA approaches
   - Including consideration of indirect land use changes
   - Increasing need for modeling approaches that are flexible, transparent, reliable and verifiable

4. LCA approaches are also useful for assessing other environmental impacts
   - Water resources
   - Eutrophication
   - Acidification
   - Habitat disruption
   - Toxicity
   - Photochemical ozone potential
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References:

Life Cycle Energy Return of Biodistillate Fuels

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