Role of Biofuels in Emission Reduction Strategies

Environment and Energy Study Institute
Rural Communities, Climate, and COVID-19 Recovery Briefing

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Outline

• Biofuels and Air Quality Impacts
• GHG Reductions
• Policies for Rural Development
Alternative Fuels and RFS

- Biofuels have not kept pace with RFS expectation but still provide benefits.
Fuel Properties and Air Quality

- **Ethanol**
  - High Octane Number: 99 (R+M)/2
  - Heat of vaporization, low sulfur, distillation properties

- **Renewable Diesel**
  - High Cetane Number: ~ 80
  - Low sulfur, no aromatics

- **Biodiesel**

- **Biogas**
  - Avoids flaring, dairy lagoons

- **Electricity & Hydrogen: ZEV**
Ethanol Blends and Air Toxics

- Aromatics
- T50
- T90
- Benzene
- Sulfur

U.S. Ozone Levels

The graph shows the trends in U.S. ozone levels and ethanol consumption from 1980 to 2015. The x-axis represents the years, while the y-axis depicts ethanol in fuel (B gal) on the left and U.S. avg ozone (ppm) on the right.

Key points:
- **Phase 1 RFG**: Indicates a phase of reduced sulfur emissions, leading to a decrease in ozone levels.
- **30 ppm Sulfur**: A significant drop in sulfur levels is represented, further reducing ozone levels.
- **Phase 2 RFG**: Shows an increase in ethanol consumption, which correlates with an increase in ozone levels.

Over time, the graph illustrates a rise in ethanol consumption and a steady increase in ozone levels, highlighting the impact of different phases on air quality.
Life Cycle Steps and Carbon Intensity

**Well to Wheel: WTW = WTT + TTW (g/mi)**

**Fuel CI: = WTT + Fuel Carbon + Vehicle CH₄, N₂O (g CO₂e/MJ)**
GHG Emissions from Petroleum Fuels

- Growth in unconventional sources
- Supply volatility
- Complex refining

System Boundary – Corn Ethanol

GHG Emissions

Energy inputs for farming

N₂O emissions from soil and water streams

Change in soil calc.

Direct land use change

Indirect land use changes for other crops and in other regions

Effective via price signal (positive impact)

Conventional Animal Feed Production

Fertilizer

CO₂ in the atmosphere

CO₂ via photosynthesis

CO₂ emissions during fermentation

Carbon in ethanol

CO₂ emissions from ethanol combustion

DGS

Effective via price signal (negative impact)
Evolution of Corn GHG Analysis

GHG Emissions

- Indirect Land Use
- Ethanol Transportation & Distribution
- Enzymes & Chemicals
- Electric Power
- NG Boiler
- Corn Transport
- Insecticide
- Herbicide
- Field CO2 from CaCO3
- CaCO3
- K2O
- P2O5
- Field Emissions
- Nitrogen Fertilizer
- CO2 emissions from urea
- Corn Farming
- Direct Land Use
- Enteric CH4
- Displaced Urea
- Displaced Soybean Meal
- Displaced Corn
- Total

Carbon Intensity (g CO₂ eMJ)
Why have a low carbon fuel program?

- Transportation is a significant portion of GHG emissions.
- Why not rely on Cap and Trade and Fuel Efficiency?
  - How to count EV GHG emissions?
  - Limited consumer incentive
- Many opportunities exist for innovation in transportation.
  - Low carbon fuels
    - Ethanol, Biodiesel, Renewable Diesel, Biogas, FT diesel, etc.
  - Electric vehicles: Battery, E85 PHEV, Hydrogen
This figure shows the percent reduction in the carbon intensity (CI) of California’s transportation fuel pool. The LCFS target is to achieve a 20% reduction by 2030 by setting a declining annual target, or compliance standard. The compliance standard was frozen at 1% reduction from 2013-2015 due to legal challenges, contributing to a build-up of banked credits as regulated parties bringing new alternative fuels to market continued to over-comply with the standard. The program will continue post 2030 at a to be determined stringency.
## GHG Reduction for Rural America

<table>
<thead>
<tr>
<th>Activity</th>
<th>GHG Savings</th>
<th>Utilization Options</th>
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<tbody>
<tr>
<td>No till farming</td>
<td>Reduce soil disturbance and enable build-up of soil carbon.</td>
<td>Corn Ethanol,</td>
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<td></td>
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<td>Switchgrass Biofuel, Oilseed Diesel.</td>
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<td>Reduced input farming. N₂O inhibitors.</td>
<td>Reduced emissions from fertilizer production and N₂O from fields.</td>
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<tr>
<td>Manure and waste utilization</td>
<td>Divert wastes from generating methane and N₂O.</td>
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<tr>
<td>Crop and forest residue utilization</td>
<td>Provide carbon neutral feedstock. Avoid decomposition in fields. Return nutrients as fertilizer.</td>
<td></td>
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<tr>
<td>Prairie and forest restoration, Buffalo trace, Habitat zone</td>
<td>Provide opportunity for soil carbon storage on land associated with crop production. Absorb nutrients from run-off.</td>
<td>Corn and soy margins. Assign land to biofuel production.</td>
</tr>
</tbody>
</table>
Complexity and Value for GHG programs

Certification Cost per Facility

- Grants
- LCFS
- Farm Level LCFS Credit
- Carbon Tax
- Cap and Trade
- Renewable Credits
- Opportunity zones, tax credits
- Purchase requirements
- Soil carbon storage/CRP land
- Corporate ESG
- Voluntary credits

Credit Value $/tonne CO$_2$

- Government: $210
- Fuel: $18
- Corporate: $5

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Lessons Learned from Fuel Programs

• Equity in GHG Reductions
  o Credits tied to GHG reductions
  o Flexibility in adopting new technologies

• Confidence for Investors
  o Losses in solar energy projects
  o Changes in RFS volume
  o Persistence in LCFS targets and price

• Technology Adoption
  o Biogas to RNG
  o Tallow to renewable diesel
  o Investments in cellulosic technology
  o Investments in electrification
Suggestions for the Future

• Support E15.
• Bring back the flexible fuel vehicle.
  o As a high octane plug in hybrid
• Add RIN pathways for hydrogen and electricity.
• Develop biomass based jet fuel from residues.
• Enable innovation.
  o Manure by wire for biorefineries
• Support farm level benefits.
  o Low emission farming
  o Habitat restoration
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