THE REALITY BEHIND THE RENEWABLE FUEL STANDARD: THE ECONOMY, AND THE ENVIRONMENT

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EESI
Environmental and Energy Study Institute
• Founded in 1984 by a bipartisan Congressional caucus as an independent non-profit organization (but receives no Congressional funding)

• Source of non-partisan information on energy and environment policy development for Congress and other policymakers

• **Climate change** is one of the most serious problems facing civilization today — impacting infrastructure, water supply, agriculture, public health and natural ecosystems
Outline:

• Transportation sector must be greened

• Do we still need biofuels?

• What is an advanced biofuel?

• GHG profile of biofuels vs. oil

• Air quality impacts of ethanol
Transportation Emissions Eclipse Power Sector

U.S. carbon dioxide emissions by sector (2005-16)

Source: U.S. Energy Information Administration, Monthly Energy Review
U.S. GHG Emissions from Transportation

- Light vehicles: 59%
- Medium/heavy trucks: 22%
- Air: 8%
- Water: 4%
- Rail: 2%
- Other: 4%
- Buses: 1%
Electric Vehicles – Not a Fad

- Volvo: all electric or hybrid cars by 2019
- VW: electric versions of all 300 models by 2030
- Mercedes-Benz: all electric by 2022
- UK, Netherlands, France: bans fossil-fuel burning cars by 2040
- China: plans to ban sale of gas/diesel vehicles

“Only a matter of time before the transition to electric vehicles takes off” – JP Morgan Chase
If EVs are the Future ...

What Do We Do in the Meantime?
We Will Use Liquid Fuels for Decades
Biofuels Need to be Done Sustainably

## Renewable Fuel Standard: EPA Fuel Categories

<table>
<thead>
<tr>
<th>Fuel</th>
<th>GHG threshold reduction (%)</th>
<th>RFS 2022 Volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional biofuel</td>
<td>20</td>
<td>15 bgal</td>
</tr>
<tr>
<td>Advanced biofuels</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Biomass based-diesel</td>
<td>50</td>
<td>21 bgal</td>
</tr>
<tr>
<td>Cellulosic biofuel</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>
Well to Wheels GHG Accounting

- **Direct inputs:**
  - Fertilizer
  - Energy

- **Outputs:**
  - Main: fuel
  - Co-products: electricity, high protein animal feed, oils.

- **Indirect inputs:**
  - Land use change
Well to Wheels GHG Accounting for Fuel Feedstocks – g CO2/mj

Percent Reduction Relative to Gasoline

90 - 103%  77 - 97%  101 - 115%

### GHG Well to Wheels: Mandated vs. Actual

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Feedstock</th>
<th>RFS GHG Reduction Mandate (%)</th>
<th>CARB/EP A Pathway actual (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cellulosic Ethanol</td>
<td>Corn stover</td>
<td>20</td>
<td>93%</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>Waste fats &amp; oils</td>
<td>50</td>
<td>78%</td>
</tr>
<tr>
<td>Biogas</td>
<td>Landfill gas</td>
<td>60</td>
<td>77%</td>
</tr>
</tbody>
</table>
Increasing Efficiency, Co-Products

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2008</th>
<th>2012</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (undenatured, gallon/bushel)</td>
<td>2.64</td>
<td>2.78</td>
<td>2.82</td>
<td></td>
</tr>
<tr>
<td>Thermal Energy (Btu/gallon, LHV)</td>
<td>36,000</td>
<td>26,206</td>
<td>23,862</td>
<td></td>
</tr>
<tr>
<td>Electricity Use (kWh/gallon)</td>
<td>1.09</td>
<td>0.73</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>DDG Yield (dry) incl. corn oil (lbs/bu)</td>
<td></td>
<td>15.81</td>
<td>15.73</td>
<td></td>
</tr>
<tr>
<td>Corn Oil Separated (lbs/bushel)</td>
<td>0</td>
<td>0.11</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td>Corn Oil Separated (% of Plants)</td>
<td>0%</td>
<td>33%</td>
<td>74%</td>
<td></td>
</tr>
<tr>
<td>Water Use (gallon/gallon)</td>
<td>5</td>
<td>2.72</td>
<td>2.7</td>
<td></td>
</tr>
</tbody>
</table>

*Table 2: Efficiency Gains in Corn to Ethanol Processing*

Steffen Muller, PhD, Lifecycle Analysis of Ethanol and Gasoline Under the Renewable Fuel Standard, UIC Engineering
Advanced Biofuels: Ethanol, Biodiesel, Jet & Marine

“Wastes”:
- Crop Residue
- Organic wastes
- Forestry waste

Purpose grown:
- Perennial grasses
- Fast growing woody crops
- Grasses
- Legumes
- Algae, cyanobacteria
Conventional crude:
- Easy to extract & refine
- Naturally occurring in liquid form

Unconventional crude:
- Energy intensive to extract & refine
- Examples: fracking, tar sands, offshore drilling
- Canadian tar sands: 18 – 21% higher emissions than conventional crude oil.

Understanding Unconventional Oil, Carnegie Endowment for Peace, 2012

Air Quality & E15

45 million Americans live, go to school or work within 300 feet of a major roadway, airport or railway. -- U.S. EPA

• Modest increases (E10 – E15) in ethanol content:
  – Reduces ozone precursors
  – Reduces GHGs
  – Reduces Volatile Organic Compounds (VOCs)
Ethanol is Clean Octane

- Gasoline contains ~25% by volume gasoline aromatics (as octane boosters)
- Ethanol is the cleanest, cheapest source of octane
- Auto manufacturers want additional octane
Increasing ethanol content decreases toxics in gasoline, such as benzene
Takeaways:

• Biofuels are STILL a necessary piece in greening the transportation sector and will continue to be

• Greenhouse gas footprint of ethanol continues to shrink while gasoline continues to rise

• Use of ethanol represents immediate reduction in tailpipe emissions, GHGs

• Renewable fuels are more than just corn ethanol – but market certainty is needed to build cellulosic space
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