Session VIII: How Will Advanced Biofuels Move Forward?

2011 Asilomar Transportation Conference

Rethinking Energy and Climate Strategies for Transportation

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Changing Motivations for U.S. Alternative Fuel Policies

- Alternative fuels have been promoted for different policy reasons.
- During the 70’s they were advocated to reduce oil import dependence.
- During the 80’s they were advocated to reduce urban air emissions.
- During the 90’s to the present time they are advocated to reduce CO₂ emissions.
- And they are again advocated to reduce oil dependence & increase fuel diversity.
Alternative fuels never achieved traction as a way to reduce urban air pollution except in heavy duty fleet vehicles (e.g., urban buses running on natural gas).

However, they forced the refining and the automobile industries to agree to more stringent pollution regulations (Clean Air Act Amendments of 1990).

As a result, current light-duty vehicles produce very low emissions (apart from CO$_2$).

A zero-emission vehicle would provide very low urban air quality benefits compared to a current conventional vehicle.
## Urban Pollution vs. GHG Emissions

<table>
<thead>
<tr>
<th></th>
<th>Air Quality Value</th>
<th>GHG Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Annual Value ($)</strong></td>
<td>17</td>
<td>150</td>
</tr>
<tr>
<td><strong>Life-Cycle Value</strong></td>
<td>170</td>
<td>1,500</td>
</tr>
</tbody>
</table>

^c Assumes 120,000 miles/vehicle and 10 year vehicle life
What Alternative Fuels Achieve Low GHG Emissions?

Percent Change in GHG Emissions Relative to Gasoline

Source: All pathways from GREET mini-tool version 1.8d.1 except LPG from GREET 1.8d.1
Alternative Fuels in Order of GHG Reduction Potential – Current Status

- **Cellulosic Biofuels**: Rapid expansion required by the 2007 Energy Independence and Security Act (EISA). However, requirements have been waived due to delays in commercial production.
- **Biodiesel**: Also required by EISA but feed stocks are very limited. Controversy over food vs. fuel and lower GHG reduction rank if indirect GHG emissions are counted.
- **H₂**: Faces substantial technology development & infrastructure challenges. Least expensive source of H₂ is natural gas. Deeper CO₂ reductions will require another feedstock. A fuel for the future.
- **Electricity**: Infrastructure mostly in place. Plug-in hybrid vehicles eliminate range and refueling obstacles to broad market acceptance. Potential to move up on the GHG savings scale as the power sector is de-carbonized. Commercial production has commenced (e.g., Chevy Volt and Nissan Leaf).
- **CNG/LNG**: Best for fleets; infrastructure/attribute issues for motorists.
- **Corn Ethanol**: Already important but controversy over food vs. fuel and indirect GHG emissions. EISA “limits” corn ethanol to 15 billion gallons.
The Promise of Cellulosic Biofuels

• Cellulosic Biofuels offer, by far, the greatest per gallon reduction in GHG emissions.
• These emission reductions do not depend on major transformations of other elements of the energy economy, for example, decarbonization of the power sector.
• Federal mandates are already in place to encourage their production and require their use (if available).
• So why are cellulosic biofuels stalled?
• And what can we do about it?
Speakers

- **Thomas Foust** (National Renewable Energy Laboratory), "Status of Cellulosic Biofuel Commercialization"
- **Ruth Scotti** (BP), "Commercializing Cellulosic Biofuels"
- **John Kneiss** (Hart Energy Publishing), "Is the Renewable Fuel Standard Sufficient to Motivate Cellulosic Biofuel Production?"
- **Jeremy Martin** (Union of Concerned Scientists), "How Do We Get Biofuels Back on Track?"
- **Kinkead Reiling** (Amyris Technologies), lead discussant
- Discussion
Appendix: Air Pollution vs. GHG Emissions Calculations

- Urban Pollution: Value of Regulated Emissions
- GHG Emissions: Value of GHG Emissions
- Urban Pollution vs. GHG Emissions
# Urban Pollution: Value of Regulated Emissions

<table>
<thead>
<tr>
<th></th>
<th>NOx</th>
<th>VOC</th>
<th>CO</th>
<th>PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier II Vehicle (bin 5) (gpm)</td>
<td>0.07</td>
<td>0.090</td>
<td>4.2</td>
<td>0.01</td>
</tr>
<tr>
<td>Emissions/Year(^a) (tons)</td>
<td>0.0008</td>
<td>0.001</td>
<td>0.025</td>
<td>0.00012</td>
</tr>
<tr>
<td>Emission Value ($/ton)</td>
<td>13,000</td>
<td>5,000</td>
<td>-(^b)</td>
<td>10,000</td>
</tr>
<tr>
<td>Annual Value ($)</td>
<td>11</td>
<td>5</td>
<td>-</td>
<td>1</td>
</tr>
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</table>

\(^a\) assumes 12k miles/year per vehicle

\(^b\) CO emissions reductions are met through the application of the VOC (NMOC) emissions standard.
# GHG Emissions: Value of GHG Emissions

<table>
<thead>
<tr>
<th></th>
<th>CH4</th>
<th>CO2</th>
</tr>
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<tbody>
<tr>
<td><strong>2016 LD Vehicle GHG Standards (gpm)</strong></td>
<td>0.03</td>
<td>250</td>
</tr>
<tr>
<td><strong>Emissions/Year (tons)</strong></td>
<td>0.0004</td>
<td>3.0</td>
</tr>
<tr>
<td><strong>Emission Value ($/ton)</strong></td>
<td>1167</td>
<td>50</td>
</tr>
<tr>
<td><strong>Annual Value ($)</strong></td>
<td>0.4</td>
<td>150</td>
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