Clean Fuels Update
May 28, 2014
Overview

1. Low carbon transportation - bottom line(s) from the research
2. California low-carbon fuel standard status review – key findings
3. Questions

Disclaimer: While my comments today are informed by the extensive research of our institute and our partners, they should not be interpreted as representing the position of the institute, our partners, the University of California at Davis, or any of the sponsors of the research.
Multiple comprehensive studies conclude that a ‘portfolio’ of advanced high-efficiency vehicles, low-carbon fuels, and more efficient land use provide the greatest potential to address both climate and energy goals while maintaining or improving transportation accessibility and affordability.
Bottom Line from the research (cont.)

1. Multiple vehicle and fuel options are being pursued that have the potential to contribute to climate/energy goals but no single option/technology can meet all of the goals;

2. Recent studies show that a portfolio of the most promising options have the potential to meet the goals and provide safe, low-carbon mobility at a per-mile cost equal to, or, in many cases, less than petroleum-based fuels at scale;
Future low-carbon fuel cost potentially < petroleum fuels

TABLE 3.2  2030 Annual Fuel Cost per LDV, Untaxed
Unless Noted

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Fuel Cost ($/gge or kWh)</th>
<th>Annual Consumer Use (gge or kWh)</th>
<th>Annual Consumer Fuel Cost ($/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline (taxed)</td>
<td>3.64/gge</td>
<td>325 gge</td>
<td>1,183</td>
</tr>
<tr>
<td><strong>Biofuel (drop in)</strong></td>
<td>3.39/gge</td>
<td>325 gge</td>
<td>1,102</td>
</tr>
<tr>
<td>Gasoline (untaxed)</td>
<td>3.16/gge</td>
<td>325 gge</td>
<td>1,027</td>
</tr>
<tr>
<td><strong>Plug-in Hybrid Electric Vehicle</strong></td>
<td>3.16/gge</td>
<td>260 gge</td>
<td>913</td>
</tr>
<tr>
<td>with 10 mile electric range</td>
<td>0.141/kWh</td>
<td>650 kWh</td>
<td></td>
</tr>
<tr>
<td>Coal-to-liquid with CCS</td>
<td>2.75/gge</td>
<td>325 gge</td>
<td>894</td>
</tr>
<tr>
<td>Gas-to-liquid</td>
<td>2.75/gge</td>
<td>325 gge</td>
<td>894</td>
</tr>
<tr>
<td><strong>Plug-in Hybrid Electric Vehicle</strong></td>
<td>3.16/gge</td>
<td>130 gge</td>
<td>752</td>
</tr>
<tr>
<td>with 40 mile electric range</td>
<td>0.175/kWh</td>
<td>1,950 kWh</td>
<td></td>
</tr>
<tr>
<td>Hydrogen fuel cell with CCS</td>
<td>4.10/gge</td>
<td>165 gge</td>
<td>676</td>
</tr>
<tr>
<td>Compressed natural gas</td>
<td>1.80/gge</td>
<td>325 gge</td>
<td>585</td>
</tr>
<tr>
<td>Battery electric vehicles</td>
<td>0.143/kWh</td>
<td>3,250 kWh</td>
<td>465</td>
</tr>
</tbody>
</table>

1. Multiple vehicle and fuel options are being pursued that have the potential to contribute to climate/energy goals but no single option/technology can meet all of the goals;

2. Recent studies show that a portfolio of the most promising options have the potential to meet the goals and provide safe, low-carbon mobility at a per-mile cost equal or in some cases less than petroleum-based fuels at scale;

3. Most non-petroleum vehicle and fuel options face non-trivial technical, economic, policy, political, and market challenges toward full commercialization;
Transportation GHG Reduction strategies

GHG Emission (MTCO2e per Year) = \[ \text{GHG (MTCO2e)} \times \text{Energy} \times \text{Efficiency} \times \text{Total Demand} \]

- Primary Energy Carbon Intensity
- Low carbon fuels
- Energy Mile
- Vehicle Efficiency
- Miles year

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What is the LCFS

- **Performance based**: GHG intensity target for transport fuels
  \[
  AFCI(\text{gCO}_2\text{-eq/MJ}) = \frac{\sum_{i} E_i \times CI_i}{\sum_{i} E_i \times EER_i}
  \]
  Total GHG emission
  Total transportation fuels produced/displaced

- **Lifecycle measurement** for “carbon intensity”

- **Regulated parties are transport energy suppliers**
  (oil providers, plus others who want to earn credits, such as biofuel, electricity, NG and H\textsubscript{2} providers)

- **Harnesses market forces**: Allows trading of credits among fuel suppliers, which provides incentives for investment and innovation in low-carbon fuels
Over 100 “Low Carbon Fuel Pathways” as Certified by the Program

Source: California Air Resources Board
Volumes of low-carbon fuels growing

- Alternative fuels under the program increased from 6.3% of total transport energy use in California in 2011 to 6.8% in the first half of 2013.
- An increasing share and volume of biofuel LCFS credits came from the use of waste-based fuels, which garnered higher premiums due to their low LCFS carbon intensity ratings and higher LCFS credit prices.
- Reported electricity use for transportation increased almost four-fold from 2011 through the first half of 2013.

Carbon intensity of low-carbon fuels improving

Fuel suppliers in the program generated excess LCFS credits beyond what was required in all quarters since the program was initiated.

Total excess credits through June 2013 totaled 1.64 Million Metric Tons CO2e, amounting to 61% more credits than required.

Every $10/ton LCFS credit price provides an incentive = ~$0.05-$0.10/gallon low-carbon fuels.

If ALL credit value is passed through to petroleum fuel costs then $10/ton credit price = ~$0.001/gallon at current (2014) stringency levels and ~$0.01/gallon at 2020 stringency levels.

* Assumes fuels with a carbon intensity of 50-90% below standard.

Primary findings from review

1. Narrow scope (focused on refinery impacts)

2. Plausible alternative assumptions exist for low-carbon fuel prices and availability would dramatically lower costs

3. Plausible alternatives for businesses and worker impacts including industries that support low-carbon fuel production would lower overall economic/jobs impact

4. Recommendations for further activities and research

1. Multiple vehicle and fuel options are being pursued that have the potential to contribute to climate/energy goals but no single option/technology can meet all of the goals;

2. Recent studies show that a portfolio of the most promising options have the potential to meet the goals and provide safe, low-carbon mobility at a per-mile cost equal or in some cases less than petroleum-based fuels at scale;

3. Most non-petroleum vehicle and fuel options face non-trivial technical, economic, policy, political, and market challenges toward full commercialization;

4. Given the long transition times involved in transportation technology and market development, actions today have very large implications for future costs/benefits;

5. Achieving energy and climate goals will require sustained public and private collaboration and durable policy signals to guide investment
THANK YOU!

For Further Info:

• UC Davis Policy Institute: policyinstitute.ucdavis.edu

Further reading:


Extra slides

Extras slides (no need to print)