Enabling Clean, Energy-Efficient Transportation with Clean Diesel Technology

NCSL Task Force on Energy Supply

May 6, 2011
Key Findings: Attitudes Toward the Energy Industry

• Results indicate a high level of concern for energy resources as compared to climate change and the transportation industry.

• Efficiency/performance and environmental impact are both viewed as important considerations, with an emphasis on energy independence, conservation, reduced petroleum consumption and finding more renewable sources of energy.
  – Among Policy Makers in particular, there is marked intensity of feeling around the importance of energy resources vis-à-vis other challenges.

• Not only is it important that automakers continue to develop engines that utilize diesel technology, there is also an expectation that fuels will continue to get cleaner and more efficient.
Reducing Transportation Related Petroleum Consumption & GHG Emissions

- Adopt more efficient technologies
- Reduce the number of vehicle miles traveled
- Use lower carbon fuels
Key Considerations

☐ Is there a primary policy objective?
  - Energy efficiency
  - Air quality improvement
  - Reducing GHG emissions

☐ What is the right balance between promoting new fuels & technologies or efficiencies in existing ones?

☐ What is the most cost effective investment?

☐ Avoiding unintended consequences
What do you think of when I say...

Diesel
How about ....
Did You Know:
Diesel Engines Power the U.S. Economy

- More than 90% of the world’s global trade is diesel-powered, when measured in tons per kilometer.
- Trade and transportation add more than $2 trillion to U.S. GDP, all relying on diesel-powered trucks, rail and marine transportation.
- Approximately 20 million people are employed by mining, construction, agricultural and other goods-producing industries which rely on diesel-powered equipment.
- Over 86% of public transportation trips were on buses and heavy rail, which are predominantly powered by diesel fuel (70% and 90% respectively).
Did You Know: Diesel Engines Power the U.S. Economy

- Approximately 1.15 million stationary diesel engines are installed at hospitals, data centers, airports and elsewhere around the country, a majority of which are emergency units, providing full power within ten seconds of an outage.

- Diesel passenger cars – make up 3.36% of vehicles, expect to be 8% by 2017. 30% better fuel economy, 20% less CO2 emissions.

- The percentage of fuel stations carrying ultra-low sulfur diesel fuel has increased from 35% in 1997 to 52% in 2007.

- Nationally, if diesel vehicles made up 15% of the passenger fleet, they would save 17 billion gallons of fuel, 413 million barrels of oil, and 205 million metric tons of CO2 by 2038.
Why is Clean Diesel part of a Sustainable Energy Strategy?

- **Efficiency**: Most fuel efficient internal combustion engine
- **Low-Emissions**: New, near zero emissions technology addresses past emissions concerns
- **Capability of hybridization and renewable fuel compatible**
- **Availability**: Fueling and maintenance infrastructure well-established
- **Solutions available for modernizing and upgrading existing engines** -- diesel retrofits among most cost-effective air quality solutions
- **Affordability**: Cost competitive in total cost of operations
## Diesel Compared to Other Fuels

### Table 2: Attributes of Diesel Relative to Fuel Alternatives

<table>
<thead>
<tr>
<th></th>
<th>Gasoline</th>
<th>Diesel</th>
<th>Ethanol</th>
<th>Biodiesel</th>
<th>LPG</th>
<th>CNG</th>
<th>Hydrogen</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Content</strong></td>
<td>1</td>
<td>+10%</td>
<td>-35%</td>
<td>+9%</td>
<td>-28%</td>
<td>-70%</td>
<td>-75%</td>
<td>N/A</td>
</tr>
<tr>
<td>Relative to Gasoline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vehicle Fuel Economy</strong></td>
<td>1 (conventional)</td>
<td>+25%</td>
<td>+35%</td>
<td>-3% (E10)</td>
<td>+23%</td>
<td>-20%</td>
<td>-5%</td>
<td>N/A</td>
</tr>
<tr>
<td>Relative to Gasoline</td>
<td>25%-30% (hybrid)</td>
<td>+25%</td>
<td>+35%</td>
<td>-25% (E85)</td>
<td>+23%</td>
<td>-20%</td>
<td>-5%</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Fuel Availability</strong></td>
<td>Widely available</td>
<td>Widely available</td>
<td>Widely available</td>
<td>Regional availability</td>
<td>Limited: most accessible alternative fuel</td>
<td>Limited</td>
<td>Minimal, most for private use</td>
<td>Available: Upgrades Eventually Needed</td>
</tr>
<tr>
<td><strong>Vehicle Availability</strong></td>
<td>All vehicle classes</td>
<td>Most vehicle classes</td>
<td>All vehicles: 10% blends</td>
<td>Limited - (E85)</td>
<td>All vehicles: 5% blends</td>
<td>Limited - (20%)</td>
<td>No OEM Conversions</td>
<td>Limited</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td>Existing</td>
<td>Existing</td>
<td>Existing for 10% blends</td>
<td>Limited</td>
<td>Limited</td>
<td>Limited</td>
<td>Limited</td>
<td>None</td>
</tr>
</tbody>
</table>

*Source: Compiled by Hart from Various Source (2010)*
Key Findings: Policymakers on Diesel

• Favorable toward diesel
• Positives outweigh the negatives
• Part of the solution to America’s energy needs
• The US will be using more diesel power in the future
• Fuel efficiency is the most frequently cited positive of diesel, followed by durability/power and improved cleanliness.
• Pollution remains the primary negative, but recognition of “clean diesel” improvements and messaging largely negates the concern.
• Diesel engines are seen as facilitating moderate environmental and energy efficiency improvements across all key economic sectors.
Key Findings: Policymakers On Clean Diesel

- Three-quarters of Policy Makers are familiar with the “clean diesel” terminology, on par with “gasoline electric hybrids” and trailing “biodiesel fuel” and “ethanol.”

- “clean diesel” (as opposed to diesel) is positive and persuasive: nearly nine-in-ten say “clean diesel” is part of the solution to America’s energy needs.

- When clean Diesel Cars are juxtaposed with other fuel technologies (gasoline car, gasoline electric hybrid, all electric car, diesel electric hybrid), they rank in the top 3 on all aspects of fuel economy, reliability, fuel efficiency, use of renewables, long term cost of owning, and powers America.

- Diesel is seen as at least as clean as what we currently have and cleaner than what it was, but not as clean as the alternatives of electricity, ethanol, natural gas and biodiesel.
Clean Diesel Is ....

- Biobased fuel sources
- No/less emissions
- Using diesel more efficiently
- Less carbon
- New technology of diesel fuels
- Burns cleaner; more efficient
- Re-designed and better for the environment
- Totally consumable and stable
- 20-25% lower CO2 emissions v. gasoline
- New technology that controls ultrafines as well as particulates
- Good in combination with hybrid tech

Qualitative responses to “When you hear the term ‘clean diesel’ what comes to mind? What is it about clean diesel that makes it different/better?”
Energy Technology Descriptors

- Among Policy Makers, when diesel is compared with electricity, ethanol, natural gas and biodiesel, diesel comes out ahead on all relevant descriptors except being clean.
- Although the variation among energy technologies is not as pronounced, the same pattern holds true among Opinion Leaders.

<table>
<thead>
<tr>
<th>Energy Technology Descriptors</th>
<th>Diesel</th>
<th>Electricity</th>
<th>Ethanol</th>
<th>Natural Gas</th>
<th>Biodiesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently available</td>
<td>61%</td>
<td>62%</td>
<td>39%</td>
<td>52%</td>
<td>55%</td>
</tr>
<tr>
<td>Proven</td>
<td>84%</td>
<td>48%</td>
<td>61%</td>
<td>42%</td>
<td>32%</td>
</tr>
<tr>
<td>Dependable</td>
<td>68%</td>
<td>37%</td>
<td>42%</td>
<td>27%</td>
<td>26%</td>
</tr>
<tr>
<td>Efficient</td>
<td>58%</td>
<td>36%</td>
<td>58%</td>
<td>39%</td>
<td>16%</td>
</tr>
<tr>
<td>Affordable</td>
<td>42%</td>
<td>26%</td>
<td>32%</td>
<td>24%</td>
<td>32%</td>
</tr>
<tr>
<td>Clean</td>
<td>23%</td>
<td>26%</td>
<td>65%</td>
<td>45%</td>
<td>32%</td>
</tr>
<tr>
<td>None of these</td>
<td>0%</td>
<td>5%</td>
<td>3%</td>
<td>5%</td>
<td>16%</td>
</tr>
</tbody>
</table>

Base: U.S. Policy Makers (N=31), Opinion Leaders (N=274)

Q32. Based on your impression of various energy technologies today, please select which attributes you associate with each of the following energy technologies...
What is the Clean Diesel System

**Advanced Engine Technology**

*Advanced engine electronic combustion control, fuel injection systems, and turbochargers optimize performance and low-emissions*

**Clean Diesel System**

**Cleaner Diesel Fuels**

*Ultra low Sulfur Diesel Fuel produces lower emissions and enable advanced emissions treatment systems (catalysts and filters)*

**Emissions Treatment**

*Particulate filters, oxidation catalysts reduce emissions of ozone-forming compounds (NOx and VOCs), trap and eliminate fine particles*
Clean Diesel Progress: Heavy-Duty Vehicles
Clean Diesel Progress: Off-Road Equipment

Large Off-Road Machines: Ag Tractors, Scrapers & Wheel Loaders

(175≤hp<300)

NOx g/Bhp-hr PM g/Bhp-hr

96% NOx REDUCTION
96% PM REDUCTION

2011-2014 Phase-In


g/Bhp-hr=grams per brake-horsepower hour NOx = Oxides of Nitrogen PM = Particulate Matter

www.epa.gov/otaq
Light-Duty Diesel Vehicles

- 20-40% more fuel efficient than gasoline vehicles
- 20% fewer CO2 emissions
- 16 2011 Model Year Vehicles Available
- More coming in 2012
  - Volkswagen Beetle
  - Mazda
Light-Duty Diesel Vehicles

- High penetration rate in Europe
  - Tax policy
  - Regulatory differences

- Low U.S. penetration, but growing.....
  - 5.7 million registered diesel vehicles in 2010 – 3.36%
  - 4 times the number of hybrid vehicles
  - J.D. Power & Associates predicts 7% by 2015 and 8% by 2017
  - Take-rates for diesel models between 50-80%
## Top 10 Lists:
### Highest numbers of registered diesel...

<table>
<thead>
<tr>
<th>Cars</th>
<th>Pickup Trucks:</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>1. Texas</td>
</tr>
<tr>
<td>Texas</td>
<td>643,660</td>
</tr>
<tr>
<td>Florida</td>
<td>2. California</td>
</tr>
<tr>
<td>Pennslyvania</td>
<td>454,478</td>
</tr>
<tr>
<td>New York</td>
<td>3. Florida</td>
</tr>
<tr>
<td>Washington</td>
<td>208,348</td>
</tr>
<tr>
<td>North Carolina</td>
<td>4. Washington</td>
</tr>
<tr>
<td>Arizona</td>
<td>172,928</td>
</tr>
<tr>
<td>Georgia</td>
<td>5. Colorado</td>
</tr>
<tr>
<td>New Jersey</td>
<td>153,186</td>
</tr>
<tr>
<td>Illinois</td>
<td>6. Oregon</td>
</tr>
<tr>
<td></td>
<td>146,760</td>
</tr>
<tr>
<td></td>
<td>7. North Carolina</td>
</tr>
<tr>
<td></td>
<td>8. Arizona</td>
</tr>
<tr>
<td></td>
<td>131,703</td>
</tr>
<tr>
<td></td>
<td>9. Georgia</td>
</tr>
<tr>
<td></td>
<td>126,216</td>
</tr>
<tr>
<td></td>
<td>10. Michigan</td>
</tr>
<tr>
<td></td>
<td>124,419</td>
</tr>
<tr>
<td></td>
<td>11. Ohio</td>
</tr>
<tr>
<td></td>
<td>124,384,</td>
</tr>
<tr>
<td></td>
<td>12. Missouri</td>
</tr>
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<td></td>
<td>124,352</td>
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</tbody>
</table>

### National Total
- **Cars:** 492,318
- **Pickup Trucks:** 4,995,360
HD pickup diesels produced from 1994-2007 will save the US 48 billion gallons of fuel

HD Pickup Truck Diesel Fuel and CO₂ Savings

Based on 1994-2007 HDPU vehicle sales. Assumes diesels did not exist and were replaced by optional gas engines. US EPA Mobile 6 VMT. Martec analysis of real world fuel economy for all engines in this segment. CO₂ savings calculated on well-to-tank basis.
If just 15% of the US fleet went diesel, we’d save 17 billion gallons of petroleum fuel.

Based on 2007 LD vehicle sales with confirmed diesel programs. Analysis assumes 2010-2015 vehicle sales over their entire useful life savings over the average 2007 vehicles with announced diesel options.
Unintended Consequences

- Want to encourage use of fuel efficient vehicles
- Allow hybrid drivers to use HOV lanes (CA, VA, NY)
- Hybrid technology excels in city driving
- Clean diesel technology excels in highway driving
- Thus… not providing incentive to most efficient vehicle.
- Alternative… provide incentive for all cars above a specific MPG rating
Heavy Duty Diesel Vehicles

A large majority of heavy-duty vehicles and off-road equipment is diesel powered

- Efficiency
- Power
- Durability
- Versatility
Heavy Duty Diesels – Continuous Improvement

- 2010 trucks showing average 5% fuel economy improvement
- Public investments in science research for diesel engine efficiency are reaping rewards in today’s commercial trucks, saving 17.6 billion gallons of fuel over a 12 year period (1995-2007).
Why is HD Vehicle Fuel Economy Important?

- Class 8 trucks use 80% of all commercial trucking industry fuel – 28% of all fuel usage.
- From 1970-2007 the number of trucks more than doubled while mileage increased 3.9%.
- Heavy duty trucks transport more than 70% of all U.S. goods purchased.
- 80 percent of all communities are serviced only by truck.
Heavy Duty Trucks Continue to Grow Cleaner and More Fuel Efficient

- Engine Improvements
  - DOE Supertruck program aiming to improve Class 8 truck fuel economy by 50%

- Truck Improvements
  - Aerodynamics
  - Materials/weight reduction
  - Rolling resistance tires

- Idle reduction technologies
What Policies Can Reduce Emissions and Fuel Consumption From HD Diesel Vehicles?

- Anti-idling
  - Limit idling time (but be realistic)
  - Enforcement
  - Incentivize purchase of technology

- Retrofitting
  - Provide voluntary incentive funding (CA, TX, NC, NY)
  - Encourage federal funding
  - Contract specifications (be mindful of limitations - clean construction principles)
Diesel Offers a Platform for Further Improvements

Diesel Hybrid Technologies

- fuel savings & emission reductions
- 40% more efficient than their conventional counterparts.
- Transit buses, school buses, work trucks – fuel savings & emissions reductions
- A recent study from Duke university noted that hybrid trucks provide an economic opportunity for the U.S., spread across all states and will add $4 billion in GDP by 2020 and $10 billion by 2030.
Diesel Offers a Platform for Further Improvements

Renewable Fuels

- Biofuels share of total transport fuel is expected to grow from 2% today to 27% in 2050.

- Using B20 biodiesel can reduce GHG emissions 15%, next generation renewable diesel can reduce them by 40-60%.

- Under the RFS2 a minimum of 800 million gallons of biomass-based diesel will be produced in 2011. Commercially produced next generation renewable diesel fuel will be available in 2013.

- According to EIA, plug in hybrid electric vehicles (PHEVs) may have higher GHG emissions than diesel vehicles using B20, depending on energy source to generate electricity.
Potential Unintended Consequences

- Public transportation
  - Provide lowest cost transportation and service to get people out of SOVs – fuel/technology choices for transit buses are secondary issues.
  - If cost of fuels and technology impact the overall fleet make-up and replacement cycle – adding more expensive technologies could make fleet air quality worse.
  - Regional Air quality impacts are going to be from fewer SOVs than any particular fuel/technology choice.
For More Information

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