American Road: Clean Diesels for the Real World

14th DEER Conference
U.S. Department of Energy
August 5, 2008
What is our national objective?

- Reduce consumption of petroleum...
- ...enhance energy security
- Stabilize and reduce GHG emissions
- Provide the greatest good at the lowest societal cost...
- ...Expand national wealth/prosperity of the US
AB 1493 forces the fleet average 26% below the 2007 EU fleet actual.

Green House Gas Emissions Overview

US car CAFE (unreformed)
US car fleet
EU fleet
ACEA Voluntary Agreement
EU Target
AB 1493 PC/LDT1
-31% in 7 years
-40% in 11 years

US and EU test cycles are not equivalent. ARB standard includes max MAC credit. AB 1493 LDT2 definition includes 8,500-10,000 lb. gvw MDPVs. Fuel economy conversions at 19.55 lb CO$_2$/gallon gasoline and 22.43 lbs/gallon diesel. US fleet excludes flex fuel credits.
US and EU – vastly different fleet characteristics.

Light Duty Fleet Characteristics

<table>
<thead>
<tr>
<th></th>
<th>US</th>
<th>EU</th>
<th>US</th>
<th>EU</th>
<th>US</th>
<th>EU</th>
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</thead>
<tbody>
<tr>
<td>Fuel Taxes/gal.</td>
<td>$0.38</td>
<td>$4.00</td>
<td></td>
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<tr>
<td>Transmissions</td>
<td>92% Automatic</td>
<td>80% Manual</td>
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<tr>
<td>Cylinder Count</td>
<td>3.5L</td>
<td>1.7L</td>
<td>23% 8-cyl</td>
<td>43% 6-cyl</td>
<td>31% 4-cyl</td>
<td>5% 3-cyl</td>
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</tbody>
</table>
The EU and PC/LDT1 fleet distribution is nearly reversed below/above ~ 1400 kg mass.
Technology enabled an already efficient powertrain to become one that the mass market wanted to drive.

European Light Duty Diesel Market Share Development

- Diesel Market Share
- + Clean
- + Quiet
- + Fun-to-drive
- Efficient

Total Fuel Consumed

Political Cost/Benefit

City
Highway
The 2007 EU diesel fleet would not meet the 2016 CA standard.

US and EU test cycles are not equivalent. ARB standard includes maximum MAC credits. Fuel economy conversions at 19.55 lbs CO₂/gallon gasoline and 22.43 lbs/gallon diesel.
Globally, light duty diesels outsell hard hybrids 30 to 1.

WTW Lifetime GHG Saved vs. OEM Mature Hardware Costs – Midsize Car

- Type E Diesel HEV: $5,500 [220%]
- Gas PHEV – CA Grid: $8,000 [320%]
- FCV – H2 from Biomass: $20,000 [800%]
- Type E Gas HEV: $3,500 [140%]
- ULEV Diesel: $2,350 [94%]

CO₂ MT Saved

OEM Hardware Cost/MT Saved
Over 1 vehicle design cycle, global prices for electrification-enabling materials rose along with oil.

2003 vs. 2008 Spot Price Index

OPEC is not the only cartel paying attention
Will the PHEV community prove technology developed for the Autobahn matches the way American’s really drive?

New GM study (Savagian) based on GPS-monitored CA mid-size sedan owners.

- Median CA driving intensity is between highway and US06 cycles
- Researcher’s objective is to prove hybrids with larger batteries are required to match the way American’s really drive
30 year-old federal test procedures are unhinged from the nation’s objective of saving real barrels and real tonnes.

Designing vehicles to artificial test standards leads to:
- Technologies that over promise and under-deliver in real-world
- Attractive real-world technologies left on the table

**109th Congress**
**H.R. 1103**
**A BILL**
**Fuel Efficiency Truth in Advertising Act of 2005**

**Real World**
**Off-Cycle**

**Societal Promise**
**On-Cycle**

**CAFE Test**
City: 55%
Hwy: 45%

**EPA Revised Sticker**
City: 43%
Hwy: 57%

**PHEV Study**

US06
City: 2/3 Fuel Used
Hwy:

**Designing vehicles to artificial test standards leads to:**
- Technologies that over promise and under-deliver in real-world
- Attractive real-world technologies left on the table
2 vehicles making a similar promise to society, but the off-cycle delivery is substantially different.

Real World vs. Lab World

<table>
<thead>
<tr>
<th></th>
<th>Camry HEV</th>
<th>Jetta TDI</th>
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</thead>
<tbody>
<tr>
<td>CAFE</td>
<td>55/45</td>
<td>55/45</td>
</tr>
<tr>
<td>Sticker</td>
<td>43/57</td>
<td></td>
</tr>
<tr>
<td>US06</td>
<td>32</td>
<td>36/40</td>
</tr>
</tbody>
</table>

- 26% decrease in real-world mpg compared to CAFE for Camry HEV.
- 35% decrease in real-world mpg compared to CAFE for Jetta TDI.
- 16% decrease in real-world mpg compared to CAFE for Jetta TDI.
The hybrid value equation is built on stop & go driving conditions, where brake energy is captured.

**Jetta TDI**
- **ULEV-II certification**
  - 49.4 ft.² footprint
  - Sticker city: 30 mpg
  - Sticker highway: 40 mpg
  - 43/57 combined: 35 mpg

**Camry HEV**
- **AT-PZEV (SULEV) certification**
  - 54.4 ft.² footprint
  - Sticker city: 33 mpg
  - Sticker highway: 34 mpg
  - 43/57 combined: 34 mpg
Societal benefit of a diesel ULEV vs. an AT-PZEV.

Based on California Energy Commission study, June 2007.
Clean Diesel Miles per Dollar Index

Miles per Dollar in a Clean Diesel Vehicle as an Index to Gasoline

1.235 More Clean Diesel Miles/$
Both consumers and the nation win with clean diesel.

**Summary**

1. To expand American prosperity, policies must achieve the greatest good at the lowest societal cost.

2. To maximize petroleum and GHG savings from the light duty fleet, focus technology where the most fuel is consumed.
   - High speed/high load drivers
   - Who accumulate the most miles per year

3. Measuring fleet fuel consumption and GHG emissions with antiquated test procedures will not align with:
   - A society that consumes 2/3\textsuperscript{rd} of all fuel in non-urban use
   - Policy makers who will be accountable in barrels and tonnes
   - Manufacturers who must survive in this “wedge”

4. To give consumers – and society – the best value for money, focus on fuel efficiency solutions that deliver:
   - Best drivability
   - Lowest variable cost increase
   - Highest demonstrated residual value performance