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American Council for an Energy-Efficient Economy (ACEEE)
May 01, 2012

Heavy-Duty Vehicle GHG Emissions and Fuel Efficiency in Canada Conference
Overview / Mission of ACEEE

ACEEE is a nonprofit organization that works to advance energy efficiency policies, programs, technologies and behaviors.

ACEEE carries out its mission by:

• Conducting in-depth technical and policy analyses
• Advising policymakers and program managers
• Working collaboratively with businesses, government officials, public interest groups, and other organizations
• Convening conferences and workshops, primarily for energy efficiency professionals
• Educating businesses and consumers through our reports, books, conference proceedings, media outreach, and Web site

December 16, 2011
Research Report T113
Authors:
Siddiq Khan and Therese Langer

Description:
Heavy-duty vehicle standards, adopted by the Environmental Protection Agency and the National Highway Traffic Safety Administration in 2011, represent an important step toward reducing fuel consumption and greenhouse gas emissions of the transportation sector. The standards cover vehicles and engines of model years 2014 through 2019 and require fuel consumption reductions ranging from 5 percent to 24 percent for later years, depending on vehicle or engine class. The program will promote the adoption of certain efficiency technologies but not others, in part due to the structure of the program, which focuses on the efficiency of components rather than the vehicle as a whole.

The next phase of the program, to begin in 2020 or before, should be based on evaluation of the full vehicle. This will have major implications for tractor-trailers and vocational vehicles, and will allow the program to drive greater savings than the current program structure permits. Prerequisites for this next phase include more complete and up-to-date data on heavy-duty vehicle usage than is available today, as well as an enhanced simulation model. The program should also include finer segmentation of vocational vehicles and a test protocol based on physical testing complemented by vehicle simulation. Test cycles and payload for each class of trucks need re-evaluation. The program should also provide information to the public sufficient to enable buyers to choose vehicles best suited to their duty cycles.

(http://www.aceee.org/research-report/t113)
Presentation Outline:

- HD Rule: History and Context
- U.S. Heavy-Duty Sector Profile
- HD Rule Description
- Areas for Improvement
- Recommendations for the Next Phase
HD GHG/FE Standards - Timeline

- **U.S. Supreme Court in 2007**: EPA can/must regulate GHG emissions
- **National Academy of Science Study**: FE potential from medium- and heavy-duty trucks completed in 2009
- **Proposed Rule**: October 2010
- **Final Rule**: July 2011
- **Program Implementation**:
  - EPA: Compliance starts for 2014 model year (MY), 2-Phase improvement in 2014 and 2017 except Pickups, No end-date
  - DOT: Compliance starts for MY 2016 and ends for MY 2019
U.S. HD Sector Complexities

• Vehicle FE never regulated or tested
• Wide range of classes from Class 2B to Class 8 with multi-dimensional applications
• Wide range of Gross Vehicle Weight (GVW) from 8,500 pounds (lbs.) to 33,000 lbs. or above
• Variations in Truck and Trailer Manufacturing
• Variations in Fuel Economy (FE) and Greenhouse Gases (GHG)
# U.S. HD Vehicle Classification

<table>
<thead>
<tr>
<th>Light-Duty</th>
<th>Medium Heavy-Duty</th>
<th>Heavy-Duty</th>
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</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Class 3</td>
<td>Class 7</td>
</tr>
<tr>
<td>Less than 6,000 lb</td>
<td>10,000 to 14,000 lb</td>
<td>26,000 to 33,000 lb</td>
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<tr>
<td>Class 2</td>
<td>Class 4</td>
<td>Class 8</td>
</tr>
<tr>
<td>6,000 to 10,000 lb</td>
<td>14,000 to 16,000 lb</td>
<td>Greater than 33,000 lb</td>
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<tr>
<td>Class 3</td>
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<td>10,000 to 14,000 lb</td>
<td>16,000 to 19,500 lb</td>
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<tr>
<td>Class 4</td>
<td>Class 6</td>
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</tr>
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<td>14,000 to 16,000 lb</td>
<td>19,500 to 26,000 lb</td>
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<tr>
<td>Class 5</td>
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<td></td>
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<td>16,000 to 19,500 lb</td>
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<tr>
<td>Class 6</td>
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<tr>
<td>19,500 to 26,000 lb</td>
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<tr>
<td>Class 7</td>
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<td></td>
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<tr>
<td>Class 8</td>
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Highway Vehicle Energy Use

- Light trucks had the largest share of highway energy consumption in 2010, consuming 8.58 quadrillion Btu (Quads) of energy.
- Cars and freight trucks followed light trucks consuming 7.59 and 4.41 Quads, respectively.
U.S. Heavy-Duty Vehicles Energy Use

- Class 2B: 11%
- Buses: 5%
- Class 3-6 Trucks: 17%
- Class 7&8 Trucks - Single Unit: 10%
- Class 7&8 Trucks - Combination: 57%

Source: ANL Vision 2011
U.S. HD Sales by Class in 2010
(in thousands)

Source: ORNL TEDB 2011
# HD Rule – Vehicles and Engines

<table>
<thead>
<tr>
<th>Rule category</th>
<th>Vehicle classes</th>
<th>Weight (GVWR)</th>
<th>Regulated entity</th>
<th>Requirement (metric)</th>
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<tbody>
<tr>
<td>Heavy-duty pick-up trucks and vans</td>
<td>Class 2b and 3</td>
<td>8,501- 14,000 lbs.</td>
<td>Vehicle manufacturer</td>
<td>Whole vehicle GHG and fuel consumption standard (g CO₂/mile &amp; gallon/100 mile)</td>
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<tr>
<td></td>
<td></td>
<td>(3.9 – 6.4 tons)</td>
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<tr>
<td>Vocational vehicles and engines</td>
<td>- Light HDV (Class 2b though 5)</td>
<td>- 8,501- 19,500 lbs.</td>
<td>- Vehicle manufacturer (chassis)</td>
<td>- Whole vehicle GHG and fuel consumption standard (g CO₂/ton-mile &amp; gallon/1,000 ton-mile)</td>
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<td>- Medium HDV (Class 6&amp; 7)</td>
<td>- 19,501- 33,000 lbs.</td>
<td>- Engine manufacturer</td>
<td>- Engine standard (g CO₂/bhp-hr &amp; gallon/100 bhp-hr)</td>
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<td></td>
<td>- Heavy HDV (Class 8)</td>
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<td></td>
<td>(15 tons and over)</td>
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<td>Combination vehicles and engines</td>
<td>Class 7 and 8</td>
<td>- 27,000- 33,000 lbs.</td>
<td>- Tractor manufacturer</td>
<td>- Whole vehicle GHG and fuel consumption standard (g CO₂/ton-mile &amp; gallon/1,000 ton-mile)</td>
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<td>tractors</td>
<td>(12- 15 tons)</td>
<td>- Engine manufacturer</td>
<td>- Engine standard (g CO₂/bhp-hr &amp; gallon/100 bhp-hr)</td>
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<td></td>
<td></td>
<td>- 33,001 lbs. and over</td>
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<tr>
<td></td>
<td></td>
<td>(15 tons and over)</td>
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</table>
Test Cycles for Vocational Vehicles and Tractors

CARB Transient Cycle + 2 Steady-State Cycles

• 55 miles per hour (89 km per hour)
• 65 miles per hour (105 km per hour)
Test Cycles for Engines: Transient and Steady-State

Federal Test Procedure (HD FTP), engine version of UDDS (below)

Supplementary Emissions Test

Cycle Weights

• Heavy-duty pickups and vans:
  • 55% city/45% highway (CAFE)

• Engines:
  • 100% FTP for vocational
  • 100% SET for tractor
# FE Standards in mpg for Selected Vehicle Classes in 2014–2019

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<td>Gasoline Pickup Trucks and Vans</td>
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<td>16.1</td>
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<td>13.5</td>
<td>13.7</td>
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<td>14.7</td>
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<tr>
<td>Class 8 Vocational Vehicles</td>
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<td>6.0</td>
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<td>6.1</td>
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<tr>
<td>Class 7 High Roof Combination Trucks, Day Cab</td>
<td>5.9</td>
<td>6.6</td>
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<td>6.8</td>
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<tr>
<td>Class 8 High Roof Combination Trucks, Sleeper Cab</td>
<td>5.7</td>
<td>7.2</td>
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<td>7.4</td>
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</tbody>
</table>
Reduction in Fuel Consumption, Baseline to 2017/2018
Projected Fuel Savings

HD Oil Consumption (million barrels per day)

Reference Case
NAS Findings
HD Rule

2010 2015 2020 2025 2030
Room for Improvement in the 2014-19 Rule:

- The rule adopts component-based approach for compliance ignoring integration of vehicle, engine, and transmission
- Engine testing does not reflect possible real-world driving application
- Trailers are not regulated
- Stringency for HD pickups is not enough to be consistent with LD trucks that share the same technologies.
- Weak vocational standards, partly due to insufficient segmentation
- Absence of labeling and simulation model functionality neglects buyer needs for information on fuel efficiency of available vehicles
Recommendations for the Next Phase:

- Full Vehicle Standards
- Chassis Testing in Test Protocol along with an updated Comprehensive Simulation
- Real-world Test Cycle and Test Weights
- Further Segmentation of Vocational Vehicles
- Consideration of Continuing Engine Standards
- Heavy Pickups and Vans with LD Standards
- Label Information of FE
Full Vehicle Standards:

- Present component-based standards will not realize the potential efficiency improvements
- Full vehicle standards optimizes integration of systems
- Will better reflect the real-world fuel consumption
- Will facilitate advanced transmission and hybrid
- May remove the need for separate engine standards
- May discourage the overpowering of engines
- Will need more inputs from manufacturers.
Test Protocol: Chassis Testing and Simulation

- Chassis testing will reflect total powertrain operation
- However, not many chassis facilities available
- Can be complemented by simulation result
- Simulation should allow for the maximum user input possible
Vocational Vehicle Segmentation:

• Baseline and final values in the first phase were affected by inadequate segmentation
• Lack of segmentation also affected determination of payload
• Segmentation by purpose and by GVW
• May follow the lead from EPA SmartWay Program
Real-World Test Cycle and Test Weight:

• Accordingly, test weightings will need re-evaluation
• Simulation tool can easily accommodate many cycles
• Test weight should reflect vehicle vocation
• Accurate test weight required to determine real-world fuel consumption
Integrating HD Trucks with LD Trucks:

- A lot of similarities between these trucks
- But FE targets for HD pickups were much lower than comparable LD pickups
- LD FE/GHG structure better suited to HD pickups and vans
Labeling/Buyers Information:

- Should show FE and GHG values on each test cycle separately
- Make online simulation tool available to public for comparing vehicles over any cycle
- Will help in maintaining public support for FE/GHG regulations
Thank you!!

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