Annual Energy Outlook 2013: Modeling Updates in the Transportation Sector

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Office of Energy Consumption and Efficiency Analysis
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Overview

• Light-duty vehicle
  – Light-duty vehicle technology update based on EPA/NHTSA Notice of Proposed Rule for model years 2017 through 2025

• Heavy-duty vehicle
  – Natural gas vehicle cost, owner/operator acceptance, and refueling availability

• Potential future updates
  – Battery and non-battery systems cost by vehicle range
  – Heavy-duty vehicle technology
  – Improve representation of HD national program and heavy-duty vehicle market
  – Natural gas for rail
Light-duty vehicle modeling update

• Light duty vehicle technology list update to include most recent information from
  
  
  – Joint Rulemaking to Establish CAFE and GHG Emissions Standards, MY 2012-2016
  
  – Average Fuel Economy Standards, Passenger Cars and Light Trucks, MY 2011, Final Regulatory Impact Analysis
  
  – Assessment of Fuel Economy Technologies for Light-Duty Vehicles, National Academies, 2010

• Changes include:
  
  – Inclusion of new technologies, cost and fuel economy benefits
  
  – Technology market penetration for model year 2010 (requires technology market penetration file from EPA/NHTSA)
  
  – Learning rates and cost reduction
  
  – Rates of market penetration
Light-duty vehicle modeling update

- Technology list includes:
  - Vehicle (Mass Reduction I to V; Aerodynamics I and II; Tires I and II; Low Drag Brakes; Secondary Axle Disconnect)
  - Transmission (6 speed Manual; 6 to 8 speed Automatic; 5 to 8 speed Dual Clutch Automated Manual; High Efficiency Gearboxes; Improved Automatic Controls/Externals I and II; Continuously Variable Transmission)
  - Accessories/Electrification (Electric Power Steering; Improved Accessories I and II; 12V Micro Hybrid; Integrated Starter Generator)
  - Engine (Conversion to SOHC and DOHC; Low Friction Lubricants; Engine Friction Reduction I and II; Cylinder Deactivation; Variable Valve Timing I to III; Variable Valve Lift I and II; Stoichiometric Gasoline Direct Injection; Turbocharging and Downsizing I to III with Cooled Exhaust Gas Recirculation for levels II and III)
  - Horsepower change from new technology
Light-duty vehicle modeling update

• Questions regarding technology list
  – Backing out learning from vehicle incremental cost in 2017
  – Incremental cost/effectiveness information on OHV, SOHC, DOHC configurations
  – Incremental cost/effectiveness information on Integrated Starter Generator
  – Ordering among the various technology trees
  – More information on Small, Medium, Large Displacement engine definition
Heavy-duty vehicle modeling update

• Natural gas vehicle incremental cost based on engine cost plus tank cost

• Natural gas vehicle engine costs
  – Class 3 engine cost: $1,417
  – Class 4 to 6 engine cost: $19,750
  – Class 7 to 8 engine cost: $33,875

• Natural gas vehicle tank costs

<table>
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<tr>
<th>Vehicle Class</th>
<th>$/dge tank capacity cost</th>
<th>Fuel type</th>
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<td>Class 7-8</td>
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</table>

Source: Cummins/Westport
Heavy-duty vehicle modeling update

- Natural gas vehicle tank sized according to vehicle miles travelled
- Natural gas vehicle incremental cost now consists of engine + tank cost:
  - Class 3: $9,750 to $37,555
  - Class 4 to 6: $34,150 to $69,250
  - Class 7 to 8: $49,075 to $86,125

<table>
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<tr>
<th>VMT Group</th>
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<th>Class 4-6</th>
<th>Class 7-8</th>
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</table>
Heavy-duty vehicle modeling update

- Natural gas fuel price for in both liquefied and compressed form, by retail or fleet operation

(2010$/dge)

Source: AEO2012, HDV Reference case
Heavy-duty vehicle modeling updates

• AEO 2012 and AEO2013 includes the HD National Program fuel efficiency and greenhouse gas emissions standards:
  – Class 3 \(\rightarrow\) (2)
    • Class 3 Pickup and Van
    • Class 3 Vocational
  – Class 4-6 \(\rightarrow\) (1)
    • Class 4-6 Vocational
  – Class 7-8 \(\rightarrow\) (10)
    • Class 7-8 Vocational
    • Class 7 Day Cab (low, mid, high)
    • Class 8 Day Cab (low, mid, high)
    • Class 8 Sleeper Cab (low, mid, high)

• AEO2012 and AEO2013 included technologies described by EPA/NHTSA in Final Rule and Regulatory Impact Analysis
Future modeling updates

• Light-duty vehicle battery electric vehicles (HEVs, PHEVs, EVs)
  – BatPaC model developed by Argonne National Lab
  – Battery Ownership Model (BOM) developed by NREL
  – Develop battery and non-battery systems cost modeling depending on power/energy ratio specific to different vehicle configurations and range

• Further study and update to heavy-duty vehicle technology attributes and penetration, vehicle market representation, and modeling of HD National Program

• Inclusion of natural gas as a fuel option for rail and inclusion of stock model for locomotives
Questions/Feedback

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