

# *Annual Energy Outlook 2013:* Modeling Updates in the Transportation Sector



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*John Maples, Patricia Hutchins, Nicholas Chase*

*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
  - Notice of Proposed Rulemaking (NPRM) for 2017 and later Model Year Light-Duty Vehicle Corporate Average Fuel Economy and Greenhouse Gas Emissions Standards, Preliminary Regulatory Impact Analysis
  - 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

Vehicle Class	\$/dgc tank capacity cost	Fuel type
Class 3	\$340	CNG
Class 4-6	\$450	LNG
Class 7-8	\$475	LNG

Source: Cummins/Westport

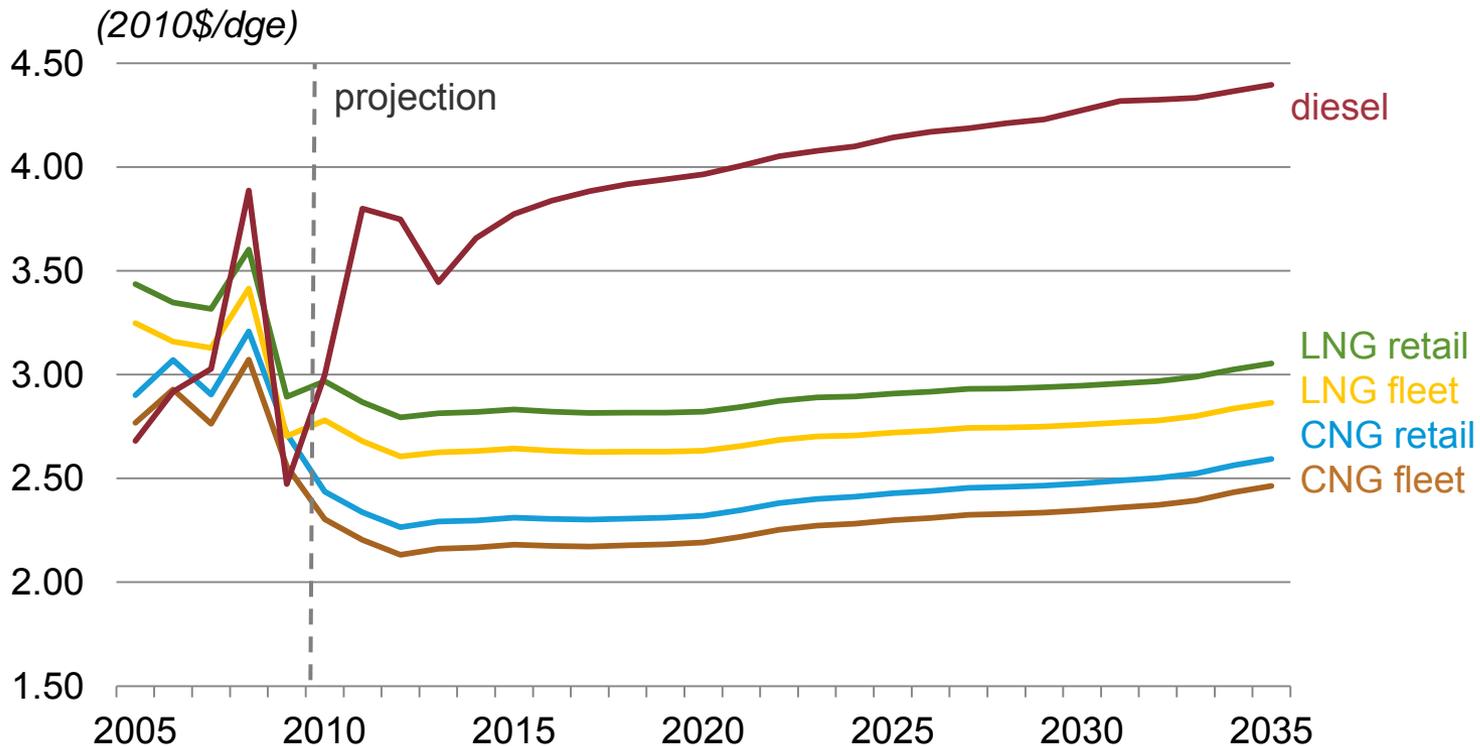
# Heavy-duty vehicle modeling update

- 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

VMT Group	Annual miles	Vehicle Cost (\$)		
		Class 3	Class 4-6	Class 7-8
1	12,554	9,750	34,150	49,075
2	27,855	9,750	34,150	49,075
3	46,021	9,750	40,000	55,250
4	62,276	12,008	44,500	60,000
5	85,000	15,872	54,400	70,450
6	110,000	20,124	60,250	76,625
7	125,000	22,675	69,250	86,125
8	147,500	26,501	69,250	86,125
9	167,500	29,902	69,250	86,125
10	187,500	33,303	69,250	86,125
11	212,500	37,555	69,250	86,125

# Heavy-duty vehicle modeling update

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



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 → (2)
    - Class 3 Pickup and Van
    - Class 3 Vocational
  - Class 4-6 → (1)
    - Class 4-6 Vocational
  - Class 7-8 → (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

**John Maples**

(202)-586-1757 [john.maples@eia.gov](mailto:john.maples@eia.gov)

**Patricia Hutchins**

(202)-586-1029 [patricia.hutchins@eia.gov](mailto:patricia.hutchins@eia.gov)

**Nicholas Chase**

(202)-586-8851 [nicholas.chase@eia.gov](mailto:nicholas.chase@eia.gov)