UPDATE ON PHASE 2 OF THE HEAVY-DUTY GREENHOUSE GAS AND FUEL EFFICIENCY STANDARDS

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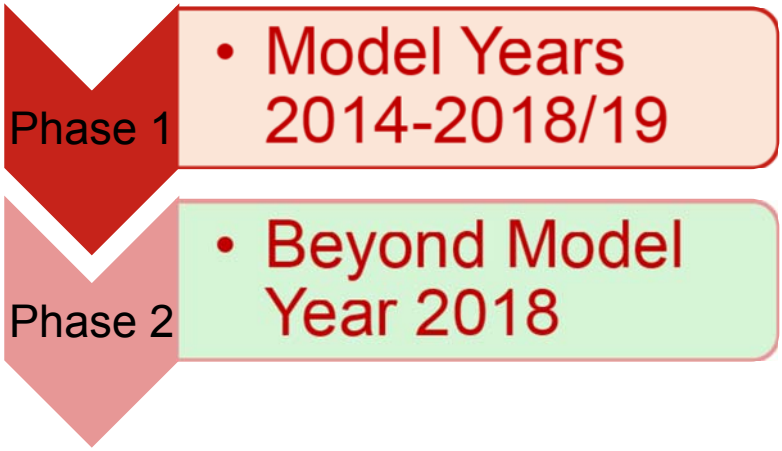
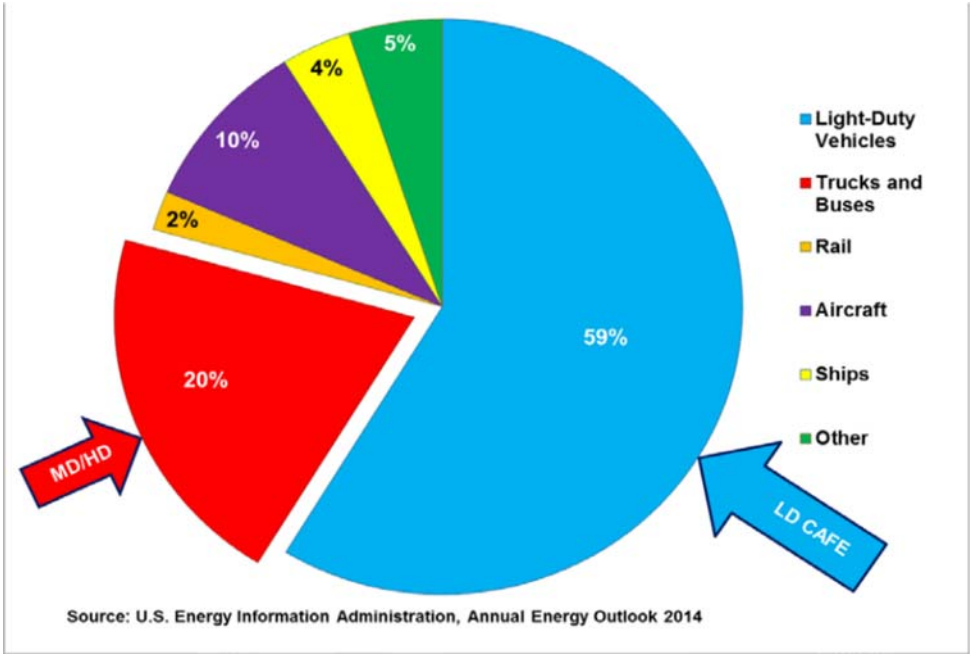
Topics

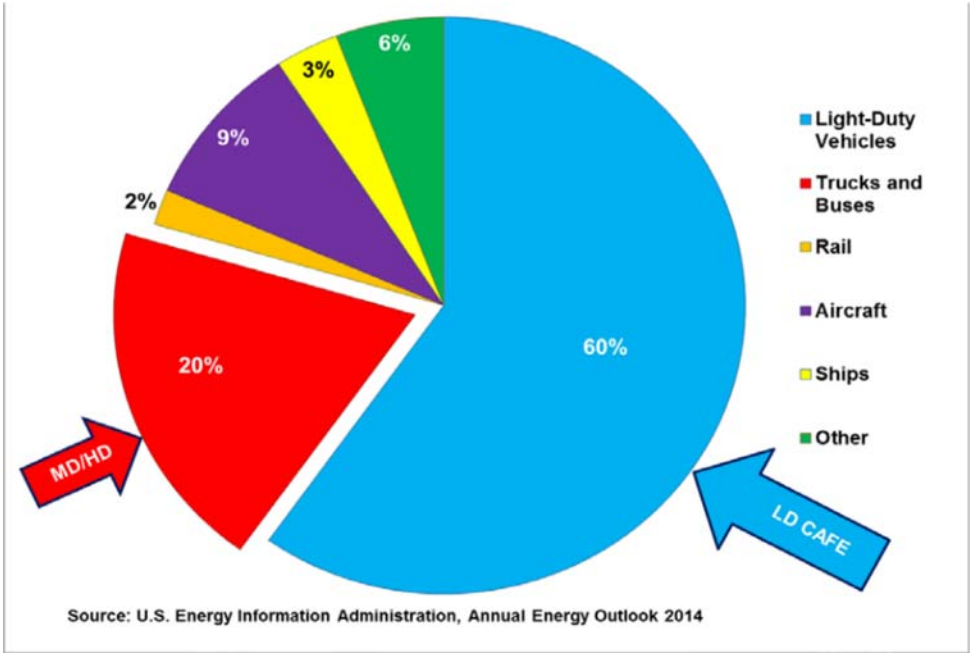
- Significance of MD/HD Emissions
- Phase 1
  Program Overview
- Phase 2
  Scope & Current Status
- Federal Research
- California Regulatory Landscape



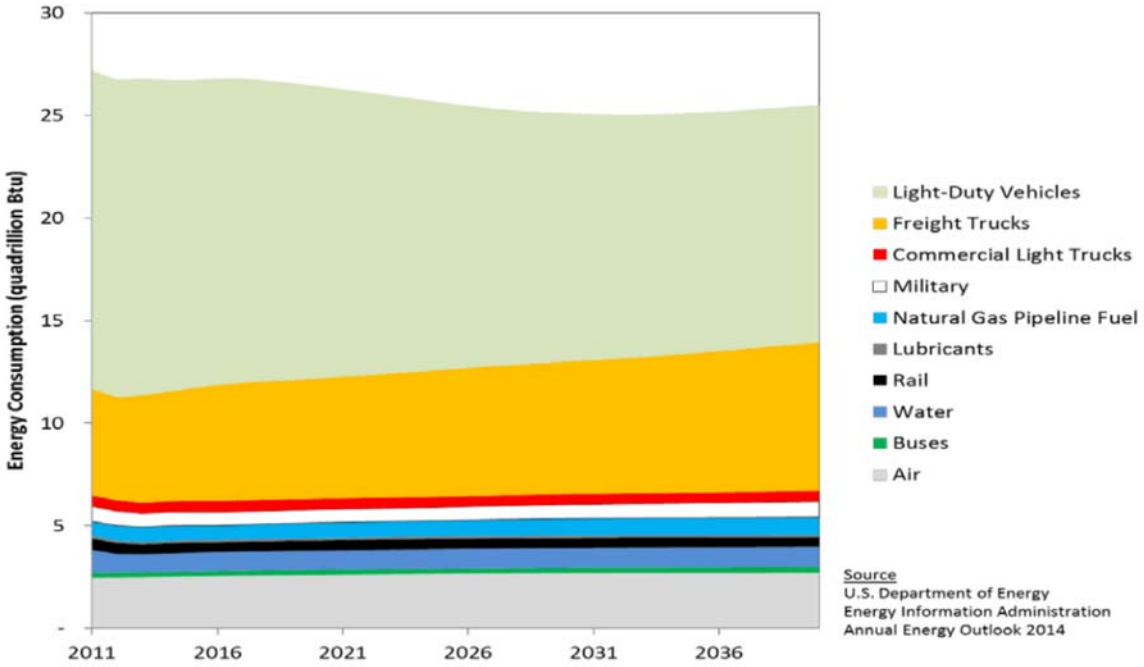
US Transportation Related GHG Emissions (Tg CO2eq)



Transportation Sector Energy Use



HD Energy Use is Projected to Grow More than Other Transportation Sectors



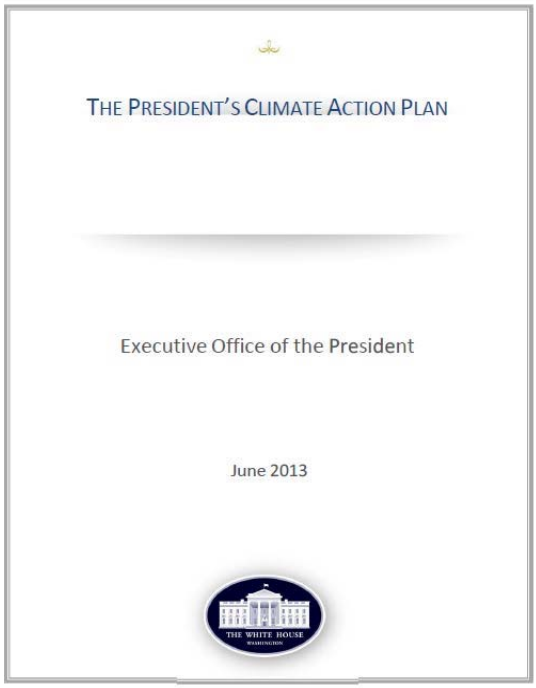
Source
U.S. Department of Energy
Energy Information Administration
Annual Energy Outlook 2014

MD/HD Phase 1 – Implementation Highlights

- First ever Medium- & Heavy-Duty Standards Implemented in 2014
- Reducing fuel consumption, CO2 emissions, and operating costs for thousands of businesses
- Allows manufacturers to produce a single fleet of vehicles to meet requirement
- EPA & NHTSA conducted significant stakeholder outreach as part of this rulemaking development
- Phase 1 focused on off-the-shelf technologies
- No 2014 pre-buy: 2014 tractor sales up 33%, trailers up 42%, vocational up 10.5% vs 2013 (ACT Research Aug 26, 2014)

- **530 million barrels less oil**
- **270 MMT lower GHGs**
- **$50 billion in fuel savings**
- **$49 billion in net benefits**

President Obama's 2013 Climate Action Plan and February 2014 Announcement



From Climate Action Plan: "During the President's second term, the Administration will once again partner with industry leaders and other key stakeholders to develop post-2018 fuel economy standards for heavy-duty vehicles ….."

From WH Fact Sheet: "This second round of fuel efficiency standards will build on the first-ever standards for medium- and heavy-duty vehicles (model years 2014 through 2018), and will reach well into the next decade."

Heavy-duty Phase 2 Rulemaking – objectives discussed in Phase 1 rule

- **Joint NHTSA/EPA rulemaking process with notice and opportunity for public review and comment.**
- **Heavy-duty Phase 2 May Include:**
  - Looking beyond off-the-shelf technology
  - Potential inclusion of trailers
  - Additional and new technologies beyond Phase 1
  - Refined test procedures and updates to the GEM vehicle simulation compliance model—a full vehicle approach that includes engines
  - Full SBREFA panel process to develop solutions for small businesses
  - Updated technology, economic and environmental assessments

Phase 2 – NHTSA/EPA Research

- **Technology Evaluations**
  - In-house and contractor modeling and testing of fuel-efficiency technologies for medium- and heavy-duty vehicles in the years prior to and in the Phase 2 timeframe
  - Evaluating the effectiveness and the costs
- **Test procedure development, refinement and validation studies**
  - Evaluating improvements to Phase 1 drive cycles, and additional idle cycle
  - Validating new aerodynamic and powertrain test procedure approaches
  - Validating a wide range of improvements to Greenhouse Gas Emissions compliance model (GEM) to fully recognize new technologies

NHTSA/EPA Research: Engine Technologies

Advanced Bottoming Cycle
Air Handling Improvement
Coolant Pump
Cylinder Deactivation
Down-sizing & Boosted vs. NA
Electric Turbo-compounding
Engine Down-sizing
Engine Down-speeding (reduced cruise RPM, combined with transmission technology)
Engine Friction Reduction
Engine Oil Pump Improvement
GDI + Cooled EGR
Improved Selective Catalytic Reduction (SCR) Conversion, combined with reducing or removing EGR
Lean Burn GDI w/ SCR
Lower Friction Engine Oil
Mechanical Turbo-compounding
Natural Gas
Reduced After-treatment Backpressure
Stoichiometric Gasoline Direct Injection (GDI)
Stop / Start
Turbo Efficiency Improvement
Variable Valve Timing

Technology application varies by vehicle class, vocation, and engine fuel type

Research on Vehicle & Trailer Technologies

A/C Reduced Reheat
Air Compressor Improvements
Automated Manual Transmission
Automatic Engine Shutdown
Automatic Tire Pressure Control
Battery Auxiliary Power Unit
Cab Insulation to Reduce A/C
Chassis Friction Reduction & Improved Lube
Diesel Auxiliary Power Unit
Driver Coaching Features
Driver Management Features
Dual Clutch Transmission
Fan Power Demand Reduction
Fuel Fired Heater
Full EV
Hybrid Technologies
Improved Aerodynamics
Improved Transmissions (more gears, higher ratio spread, shift points)
Low Rolling Resistance Tires
Manual Transmission
Shore Power
Single Wide Tires
Tractor Axle 6X2 or Clutched 6X4
Speed limiters
Weight Reduction

Technology application will vary by vehicle class, vocation, and engine fuel type

National Academies of Science

- **2010**
  - Issued, “Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles”
  - EPA and NHTSA considered this study in support of Phase 1; similar for Phase 2

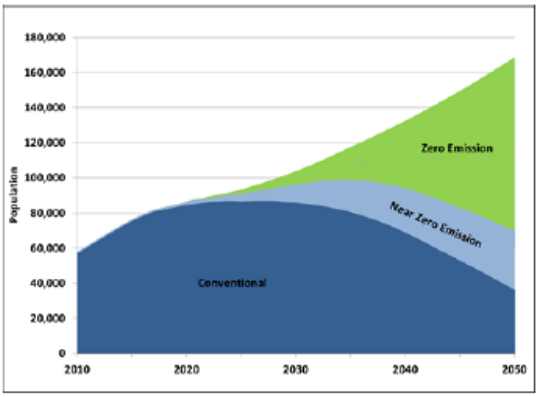
- **2014**
  - NHTSA sponsored a second NAS study for heavy-duty
  - Published an interim report in April 2014 to help inform Phase 2
  - Final report expected in 2016 to inform considerations beyond Phase 2

What's Happening in California?

- **2008: ARB adopted mandatory fleet-level requirements for tractors and trailers**
  - Based on EPA SmartWay performance
- **2012: ARB Released 2050 Vision for Clean Air document**
  - Calls for significant additional NO_x and CO_2 reductions from heavy-duty sector
- **2013: Adopted EPA GHG Phase 1 Standards**
  - Board hearing in December 2013
  - Similar to ARB's adoption of HD criteria emissions standards
  - Also adopting new voluntary Low NOx standards for heavy-duty
  - Signaled intent to move beyond Federal Phase 1
  - Sunsetted CA fleet-level program for tractors, but not for trailers
- **2014: ARB is significantly engaged on Phase 2**

California Environmental Protection Agency
Air Resources Board

South Coast Heavy Duty Truck Population
(advanced technology scenario)



Wrap-up

- **The fastest growing transportation sub-sector is heavy-duty. Reducing GHGs and fuel consumption from this sector will be vital toward addressing climate change and energy security.**
- **EPA and NHTSA are currently implementing the first-ever national program for medium- and heavy-duty GHG and fuel efficiency, & the program has been a success.**
- **EPA and NHTSA are committed to fulfilling the President's Climate Action Plan by proposing and finalizing "Phase 2" of this national program.**
- **Significant technical and analytical work is underway to develop Phase 2.**
- **For Phase 2 EPA and NHTSA are continuing our significant stakeholder outreach, which helped make Phase 1 a success.**