

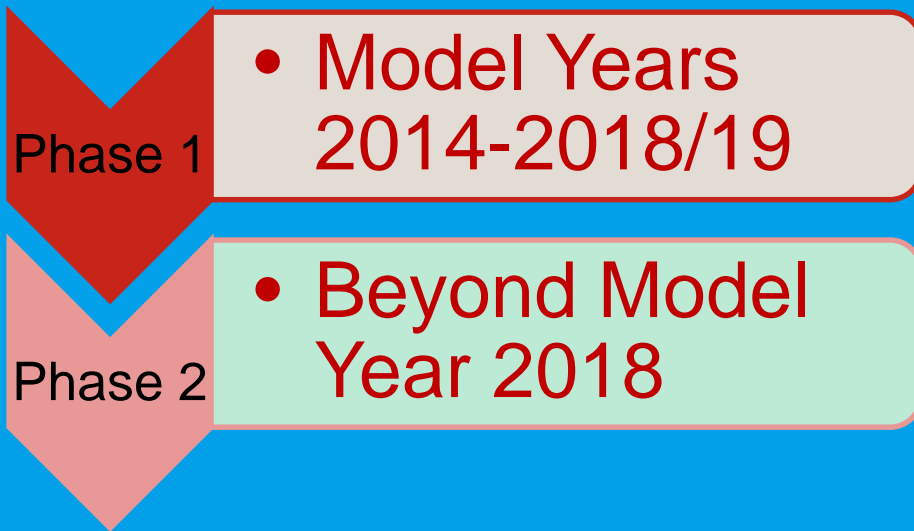
LOOKING AHEAD TO THE NEXT PHASE OF HEAVY-DUTY GREENHOUSE GAS AND FUEL EFFICIENCY STANDARDS

U.S. Environmental Protection Agency
National Highway traffic Safety Administration



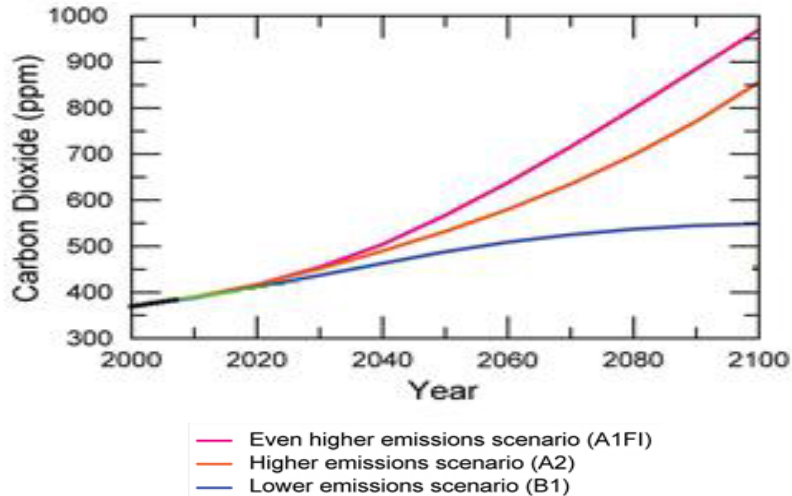
Topics

- MD/HD Emissions
- Phase 1
 - Program Overview
- Phase 2
 - Possible Scope
 - Federal Research
- California and International Regulatory Landscape

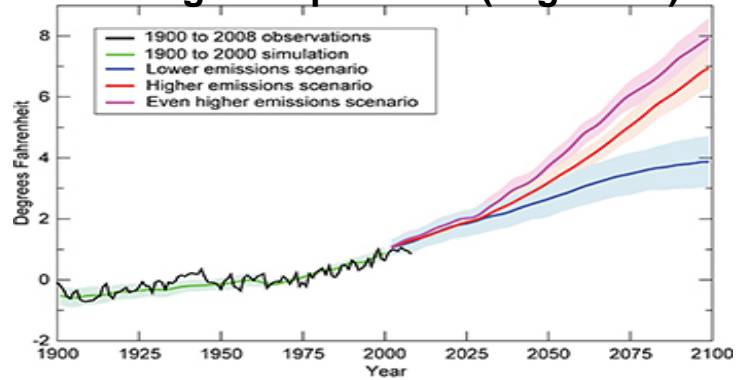


Why GHG Emissions Matter

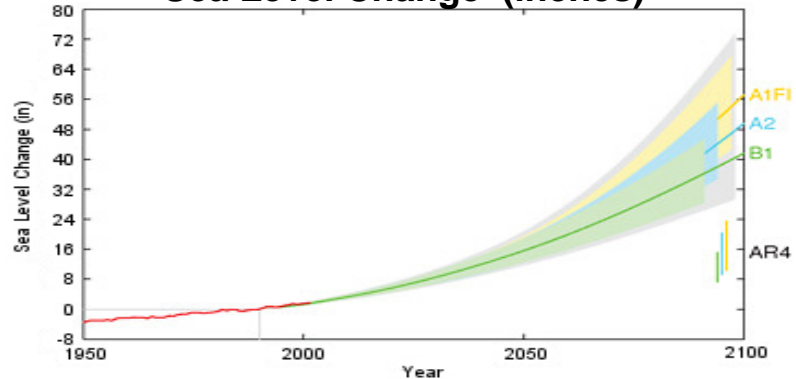
Atmospheric CO₂ Concentration (ppm)



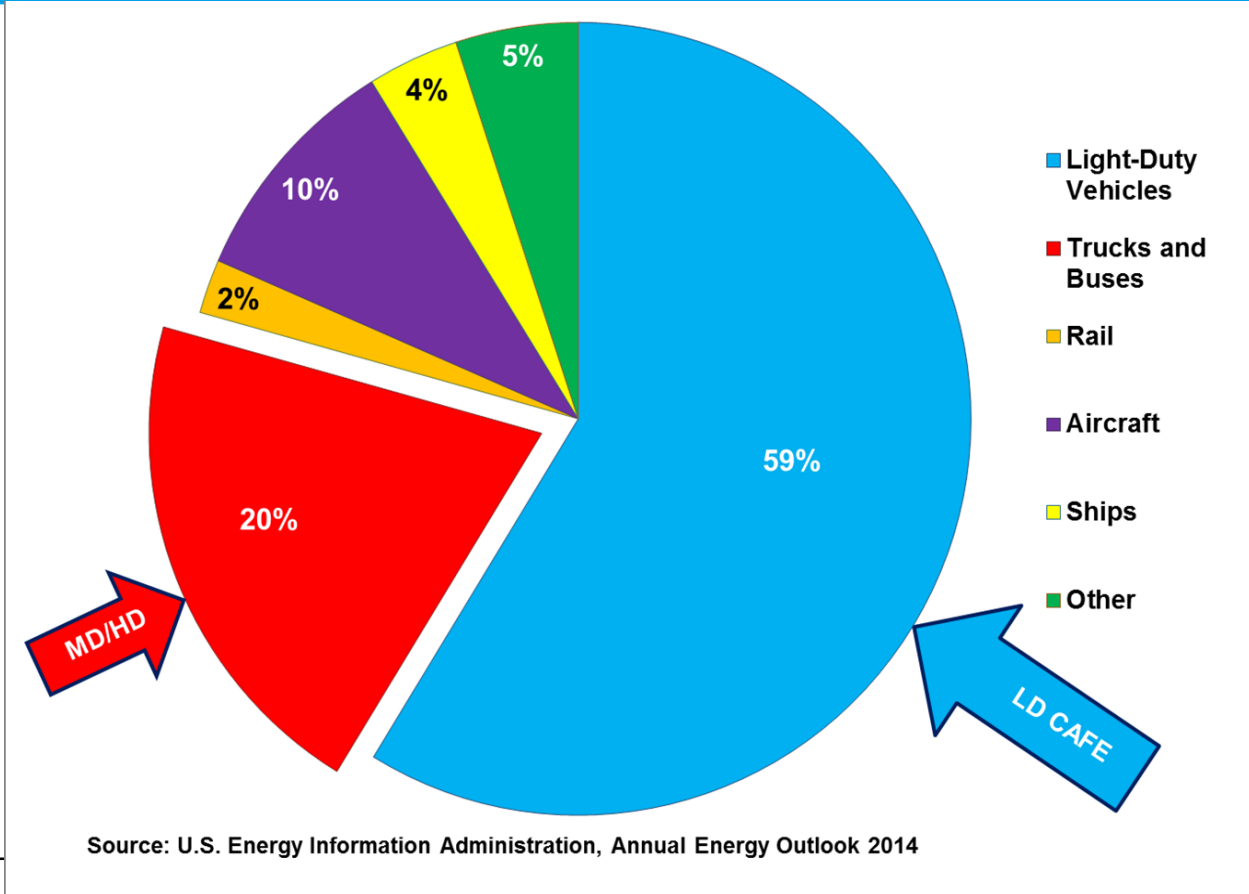
Average Temperature (degrees F)



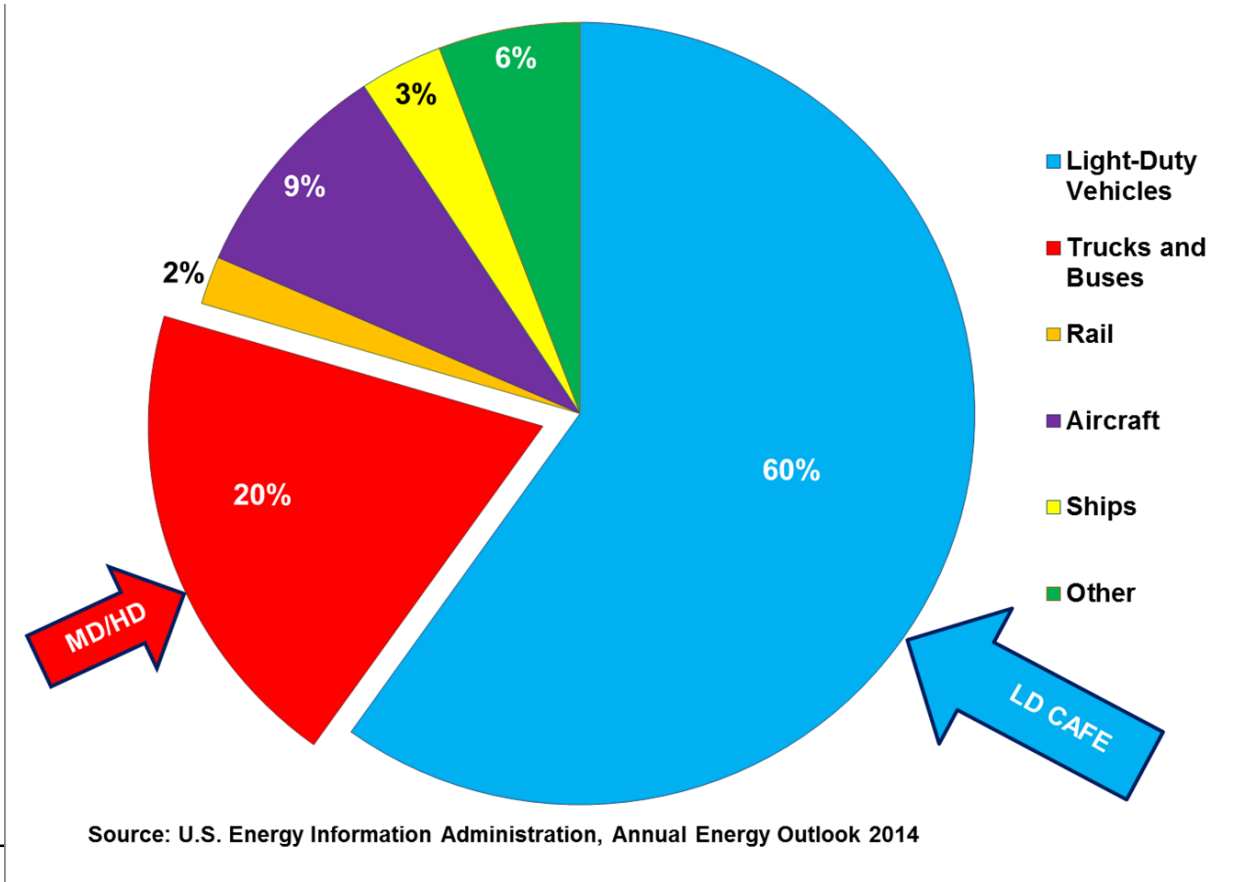
Sea Level Change (inches)



US Transportation Related GHG Emissions (Tg CO₂eq) 2012



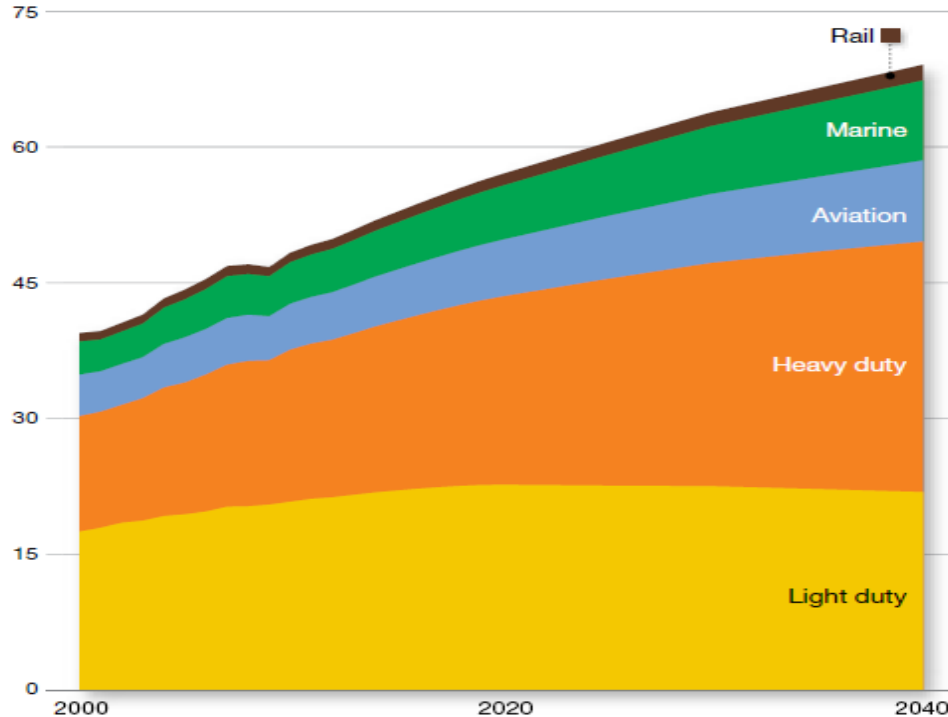
Transportation Sector Energy Use 2012



World-Wide Transportation Energy Use: HD Vehicle Grows Faster than any Other Transportation Sub-sector

Transportation energy demand by sector

Millions of oil-equivalent barrels per day

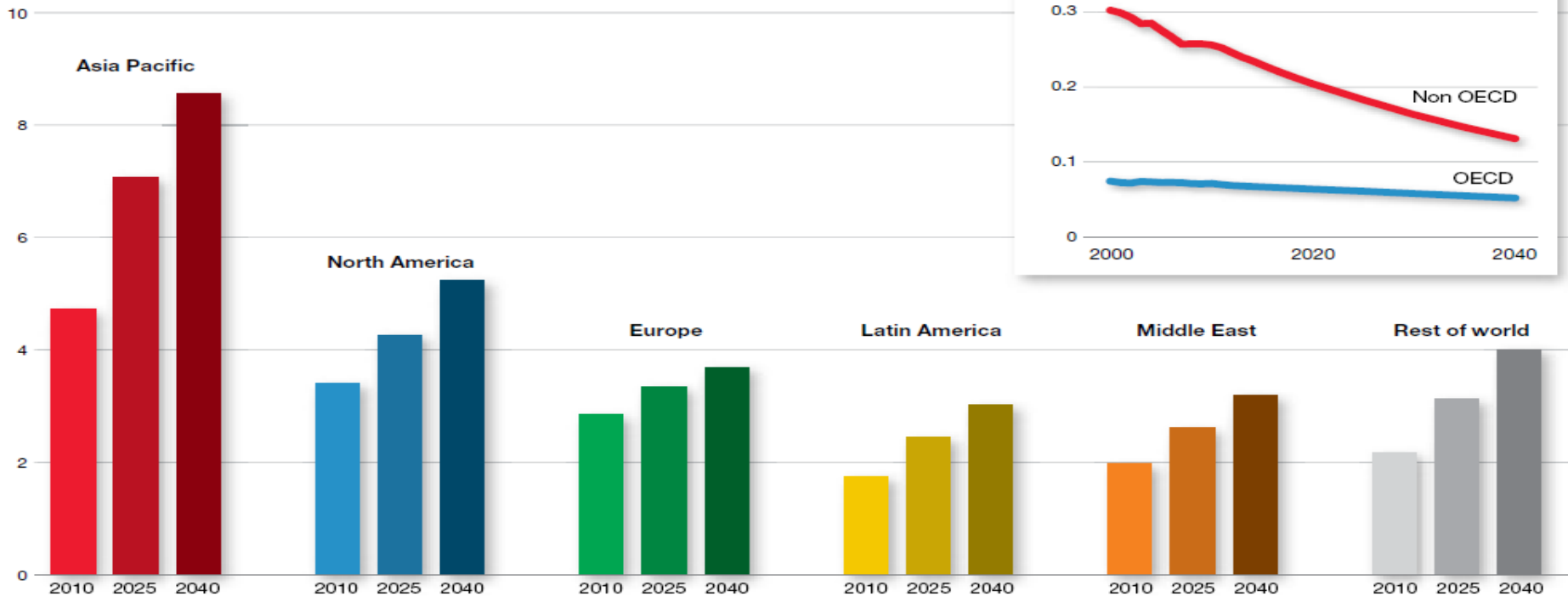


- World-wide, HD vehicle energy demand estimated **to grow by 65%** over next 30 years
- In 2040, HD Vehicles projected to be largest transportation sub-sector use of energy.
- **40%** of all transportation energy

World-Wide Transportation Energy Use: Heavy-duty Grows in All Regions, with Asia Pacific by Far the Largest

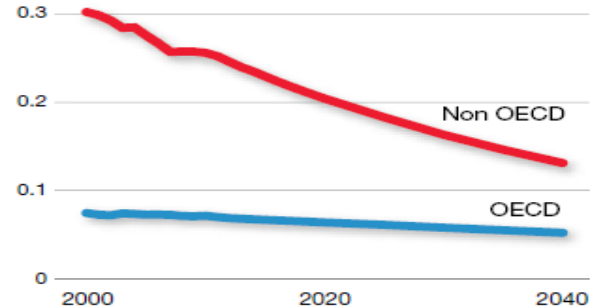
Heavy duty transportation demand by region

Millions of oil-equivalent barrels per day



Heavy duty transportation intensity

Oil-equivalent barrels per thousand dollars of GDP



ExxonMobil 2013 Energy Outlook Report

MD/HD Phase 1 – Highlights

- **First ever Medium- & Heavy-Duty Standards**
- **Will reduce 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**
- **530 million barrels less oil**
- **270 MMT lower GHGs**
- **\$50 billion in fuel savings**
- **\$49 billion in net benefits**



Phase 1 – Standards Implementation

- **EPA GHG standards are mandatory beginning in Model Year 2014**
- **NHTSA fuel efficiency standards are mandatory beginning in Model Year 2016**
 - Voluntary early compliance MY 2014 & 2015

	2014	2015	2016	2017	2018	2019
GHG stds.	M	M	M	M	M	M
Fuel efficiency stds.	V	V	M	M	M	M

Phase 1 – Divides diverse MD/HD vehicle sector into 4 distinct categories

Semi tractors (not trailers)



Full-size pickup trucks & work vans



Vocational vehicles



Heavy Duty Engines



Phase 1 – Pollutants addressed and flexibilities

- EPA regulates CO₂, N₂O, CH₄ and HFCs.
- NHTSA regulates fuel consumption.
- Both agencies offer manufacturers flexibilities including credit Averaging, Banking and Trading (ABT), among other provisions



Greenhouse Gas Emissions Model (GEM)

Identification

Manufacturer Name: Vehicle Configuration: Date:
Vehicle Family: Vehicle Model Year:

Regulatory Subcategory

Class 8 Combination - Sleeper Cab - High Roof
 Class 8 Combination - Sleeper Cab - Mid Roof
 Class 8 Combination - Sleeper Cab - Low Roof
 Class 8 Combination - Day Cab - High Roof
 Class 8 Combination - Day Cab - Mid Roof
 Class 8 Combination - Day Cab - Low Roof
 Class 7 Combination - Day Cab - High Roof
 Class 7 Combination - Day Cab - Mid Roof
 Class 7 Combination - Day Cab - Low Roof
 Heavy Heavy-Duty - Vocational Truck (Class 8)
 Medium Heavy-Duty - Vocational Truck (Class 6-7)
 Light Heavy-Duty - Vocational Truck (Class 2b-5)

Simulation Inputs

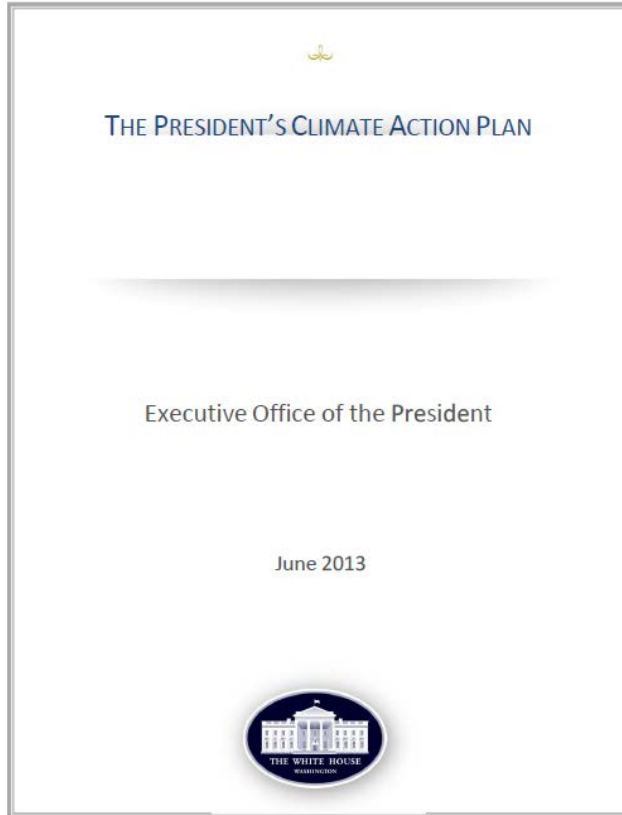
Coefficient of Aerodynamic Drag:
Steer Tire Rolling Resistance (kg/metric ton):
Drive Tire Rolling Resistance (kg/metric ton):
Vehicle Speed Limiter (mph):
Vehicle Weight Reduction (lbs):
Extended Idle Reduction:

Simulation Type

Single Configuration
 Plot Output
 Multiple Configurations

RUN

President Obama's 2013 Climate Action Plan: Commitment to a Phase 2 Regulatory Program for Heavy-duty Vehicles



“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

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:**
 - Potential inclusion of trailers
 - Additional and new technologies beyond Phase 1
 - Refined test procedures and updates to the GEM vehicle simulation compliance model
 - Updated technology, economic and environmental assessments
 - Updating flexibilities

Phase 2 – NHTSA/EPA Research

➤ **Technology Evaluations**

- Study of fuel-efficiency technologies for medium- and heavy-duty vehicles in the years prior to and in the Phase 2 timeframe
- Evaluate the effectiveness and costs

➤ **Test procedure development, refinement and validation studies**

- Evaluate improvements to Phase 1 drive cycles, and additional cycles
- Refine and evaluate aerodynamic and powertrain test procedure approaches
- Considering improvements to Greenhouse Gas Emissions compliance model (GEM)

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

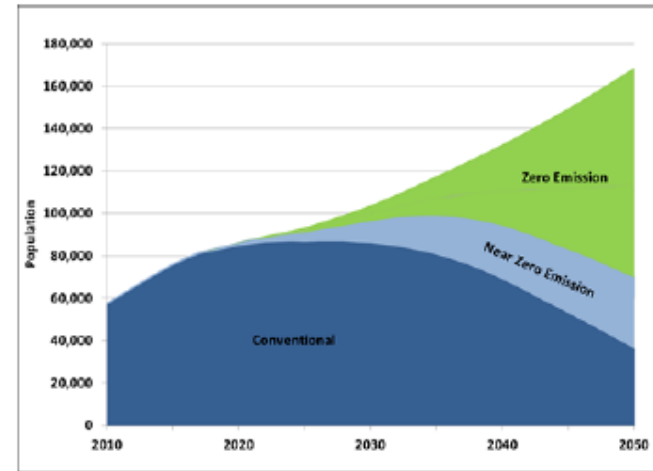
- **2010**
 - Issued, “Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles”
 - EPA and NHTSA considered this study in support of Phase 1
- **2014**
 - As required by 2007 Energy Independence and Security Act, NHTSA sponsored a second NAS study for heavy-duty
 - Published an interim report in April 2014 to help inform Phase 2 considerations
 - Final report expected in 2016 to inform considerations beyond Phase 2

What's Happening in California?

- **2008: ARB adopts mandatory fleet-level requirements for tractors and trailers**
 - Based on EPA SmartWay performance
- **2012: ARB Releases 2050 Vision for Clean Air document**
 - Calls for significant additional NO_x and CO₂ reductions from heavy-duty sector
- **2013: Adopting 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 NO_x standards for heavy-duty
 - Signaled intent to move beyond Federal Phase 1
- **ARB Participation in Federal Phase 2 Standards Development**



South Coast Heavy Duty Truck Population
(advanced technology scenario)



What's happening Internationally?

- **North America (Environment Canada / Transport Canada)**
 - Canada finalizing adoption of US HD GHG Phase 1
 - EPA/NHTSA coordinating Phase 2 technical work with EC & TC
- **Europe (DG CLIMA / DG JRC)**
 - Developing test procedures and a simulation tool
 - Evaluating a range of policy options
 - Initial direction might include reporting or labeling
- **China (MIIT / CATARC)**
 - Finalized an industry standard based on chassis dyno testing parent vehicles and simulating child variants
 - Working toward national standards
- **Japan (MLIT / NTSEL)**
 - First movers in regulatory world with “top-runner” program
 - Supporting opportunities for international harmonization

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.**
- **EPA and NHTSA are committed to fulfilling the President's Climate Action Plan by proposing and finalizing "Phase 2" of this national program.**
- **EPA and NHTSA will propose rule by end of March 2015 and finalize rule by end of March 2016.**
- **Significant technical 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.**