



HD GHG Phase 2 in MOVES

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September 14, 2016

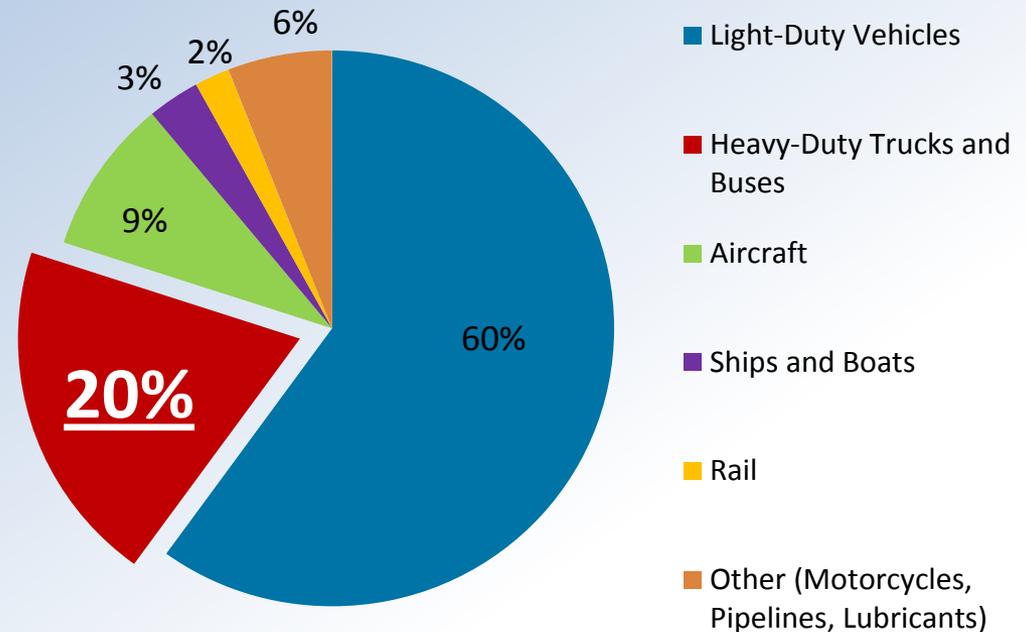


BACKGROUND



U.S. Transportation Sector Energy Use

- Heavy-duty vehicles account for about one fifth of the energy use and GHG emissions from transportation sources
- In terms of energy use, heavy-duty vehicles are also the fastest growing transportation sector in the U.S. and globally



Source:
U.S. Energy Information Administration Annual Energy Outlook 2014



Heavy-Duty Truck Regulatory Categories

Combination Tractors



Trailers Pulled by
Combination Tractors
(currently unregulated
federally)



NEW!

60% of HD Fuel Consumption
& GHG Inventory (together)

Vocational Vehicles



17% of HD Fuel Consumption &
GHG Inventory

Large Pickups & Vans



23% of HD Fuel Consumption
& GHG Inventory



HD GHG PHASE 2 RULE



Overview of HDGHG Phase 2

- Adopted jointly by EPA and NHTSA
- Reduce carbon emissions and fuel consumption from medium- and heavy-duty engines and vehicles
- Technology-advancing standards that can be met through a combination of existing technologies and advanced technologies
- Begin in 2018 for trailers and in 2021 for all other HD categories
- Standards fully phased-in by 2027



Phase 2 Technologies

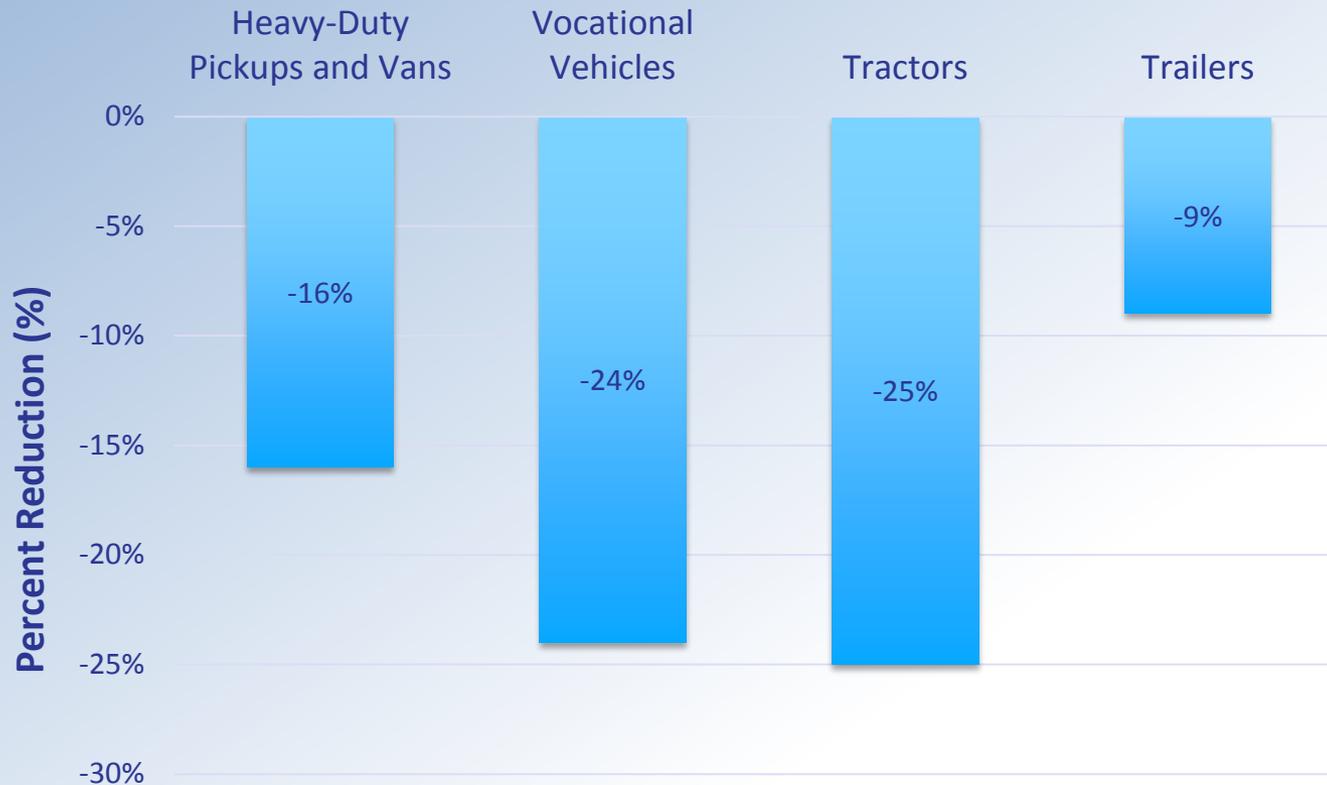
	Tractors	Trailers	Vocational Vehicles	HD Pickups and Vans
Engine	✓		✓	✓
Transmission	✓		✓	✓
Driveline	✓		✓	✓
Aerodynamic design	✓	✓		✓
Tire rolling resistance	✓	✓	✓	✓
Weight reduction			✓	
Idle reduction	✓		✓	
Hybridization			✓	✓

<https://www3.epa.gov/otaq/climate/regs-heavy-duty.htm>



Phase 2 Per Vehicle Reductions

- Maximum reductions in CO₂ and fuel consumption relative to Phase 1



Additional Key Phase 2 Provisions

- Particulate matter (PM) standards for diesel auxiliary power units (APUs) installed on new tractors for hoteling
 - Most likely achieved through installation of diesel particulate filter (DPF)
 - Ensure no increase in PM
- Adopting new requirements for most gliders to have engines installed that meet the same requirements new emissions-compliant engines must meet

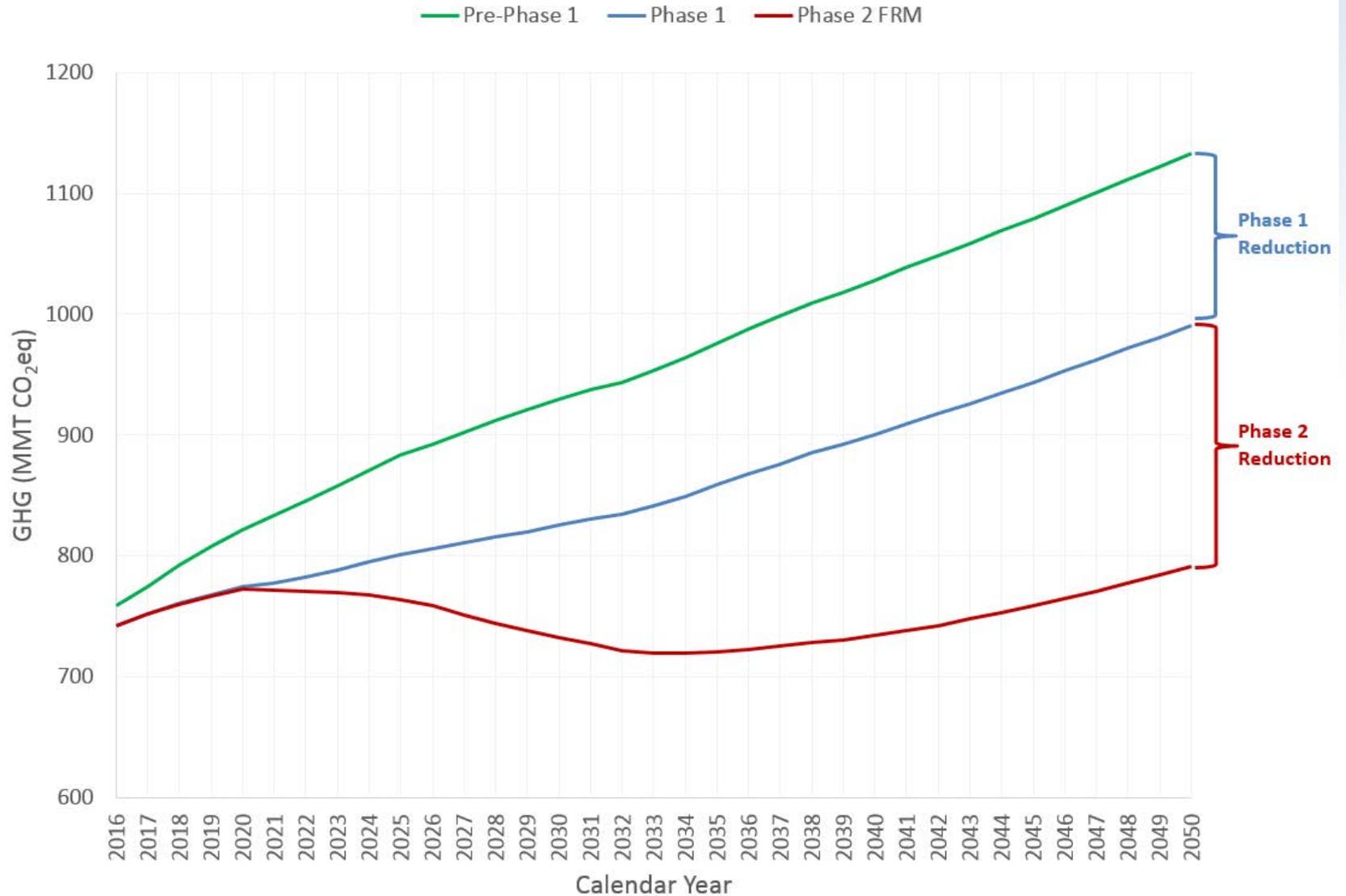


Impacts on GHGs

- Reduced GHG emissions due to engine and vehicle improvements
 - Decrease in methane (CH₄) expected from increased penetration of APUs
- MY lifetime GHG reductions
 - Reductions that occur over the lifetimes of the vehicles produced during the model years subject to the Phase 2 standards

CO ₂ reductions:	Equivalent fuel savings:
1.1 Billion MMT CO₂eq	82 Billion Gallons

Total Annual GHG Trends for Phase 2



Impacts on Non-GHGs

- Reductions[†] in emissions of criteria pollutants and air toxics expected due to
 - Anticipated increase in APU usage during extended idling
 - Reduced road load (improved aerodynamics and tire rolling resistance)
 - Requirement for additional PM control on APUs

2050 National Inventory Impacts

	CY2050	
	US Short Tons	% Reduction
NOx	-123,824	-13.3%
PM2.5	-6,100	-12.1%
VOC	-29,253	-13.0%
1,3-Butadiene	-9	-4.1%
Acetaldehyde	-61	-2.1%
Acrolein	-5	-1.3%
Benzene	-192	-7.5%
CO	-63,869	-3.8%
Formaldehyde	-227	-2.9%

[†] Reductions estimated using the regulatory version of MOVES2014a, compared to the baseline assuming Phase 1

MODELING OF HDG₂ IN MOVES



Carbon Dioxide (CO₂)

- MOVES calculates CO₂ emissions from total energy consumption
 - Energy rates stored in “emissionrate” table
 - Current default accounts for Phase 1 standards
- Applied energy reductions expected from Phase 2
 - To “emissionrateadjustment” table by regulatory class, source type, and fuel type
 - Energy rates meeting Phase 1 adjusted by the percent reduction from Phase 2
 - Phase 2 adjustments account for engine improvements, as well as improvements in transmissions, axles, tire inflation systems, etc
- For percent reductions from Phase 2, see Appendix



Improvements in Road Loads

- MOVES uses the vehicle characteristics to estimate the power needed for different types of operation
 - Higher power linked to higher emissions
- Since the Phase 2 vehicles are required to be more efficient, they will spend less time in high emission modes
- Modeled by modifying the “sourceusetypephysics” table
 - To account for expected changes in tire rolling resistance, coefficient of drag, and weight reductions
 - By regulatory class and source type
 - For combination tractor-trailers and vocational vehicles
- For percent improvements in road loads, see Appendix



Changes to Hoteling Activity

- Changes to baseline penetration of APUs during extended idling
 - MOVES2014a: 30%
 - Phase 2: 9%

- Anticipated APU penetration rates in Phase 2

Model Year	Diesel APUs	Battery APUs
2021-2023	30%	10%
2024-2026	40%	10%
2027 and later	40%	15%

- Stored in “hotellingactivitydistribution” table



Updates to Extended Idle and APU Rates

- Revised emissions rates for extended idle and APUs reflecting new data
 - Based on comments received from the proposal
 - Significantly lower extended idle emission rates compared to MOVES2014a
- Model PM standards for diesel APUs in Phase 2
- To be presented at future FACA meetings



APPENDIX



Emission Rate Adjustment – Tractor-Trailers

Regulatory Class	Source Type	Fuel	Model Years	Adjustment
MHD & HHD	Combination Long-Haul	Diesel	2018-2020	-1.0%
			2021-2023	-7.9%
			2024-2026	-12.4%
			2027 and later	-16.3%
	Combination Short-Haul	Diesel	2018-2020	-0.6%
			2021-2023	-7.4%
			2024-2026	-11.9%
			2027 and later	-15.0%



Emission Rate Adjustment – Vocational Vehicles

Regulatory Class	Source Type	Fuel	Model Years	Adjustment
LHD, MHD, and HHD (14k lbs < GVWR)	<ul style="list-style-type: none"> • Intercity Bus • School Bus • Refuse Truck • Single Unit Short-Haul Truck • Single Unit Long-Haul Truck • Motor Home 	Diesel & CNG	2021-2023	-7.8%
			2024-2026	-12.3%
			2027 and later	-16.0%
		Gasoline	2021-2023	-6.9%
			2024-2026	-9.8%
			2027 and later	-13.3%
Urban Bus	<ul style="list-style-type: none"> • Transit Bus 	Diesel & CNG	2021-2023	-7.0%
			2024-2026	-11.8%
			2027 and later	-14.4%



Emission Rate Adjustment – HD Pickups and Vans

Regulatory Class	Fuel	Model Years	Adjustment
LHD (GVWR <= 14k lbs)	Gasoline and Diesel	2021	-2.50%
		2022	-4.94%
		2023	-7.31%
		2024	-9.63%
		2025	-11.89%
		2026	-14.09%
		2027 and later	-16.24%



Road Load Improvements – Tractor-Trailers

Source Type	Model Years	Reduction in Tire Rolling Resistance Coefficient	Reduction in Aerodynamic Drag Coefficient	Weight Reduction (lb)†
Combination long-haul tractor truck	2018-2020	6.1%	5.6%	-140
	2021-2023	13.3%	12.5%	-190
	2024-2026	16.3%	19.3%	-294
	2027 and later	18.0%	28.2%	-360
Combination short-haul tractor truck	2018-2020	5.2%	0.9%	-23
	2021-2023	11.9%	4.0%	-43
	2024-2026	14.1%	6.2%	-43
	2027 and later	15.9%	8.8%	-43

† Negative weight reductions reflect an expected weight increase as a byproduct of aerodynamic improvements and other improvements to the vehicle



Road Load Improvements – Vocational Vehicles

Source Type	Model Years	Reduction in Tire Rolling Resistance Coefficient	Weight Reduction (lb)
Intercity Bus	2021-2023	18.2%	0
	2024-2026	20.8%	0
	2027 and later	24.7%	0
Transit Bus	2021-2023	0%	0
	2024-2026	0%	0
	2027 and later	12.1%	0
School Bus	2021-2023	10.1%	0
	2024-2026	14.9%	0
	2027 and later	19.7%	0
Refuse Truck	2021-2023	0%	0
	2024-2026	0%	0
	2027 and later	12.1%	0

Road Load Improvements – Vocational Vehicles (cont'd)

Source Type	Model Years	Reduction in Tire Rolling Resistance Coefficient	Weight Reduction (lb)
Single Unit Short-Haul Truck	2021-2023	6.4%	4.4
	2024-2026	6.4%	10.4
	2027 and later	10.2%	16.5
Single Unit Long-Haul Truck	2021-2023	8.4%	7.9
	2024-2026	13.3%	23.6
	2027 and later	13.3%	39.4
Motor Homes	2021-2023	20.8%	0
	2024-2026	20.8%	0
	2027 and later	24.7%	0

