

California and Federal Standards for Fuel Economy, CO₂, and NO_x



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Session 3: Drivers for Purchase of MD/HD Truck Technologies

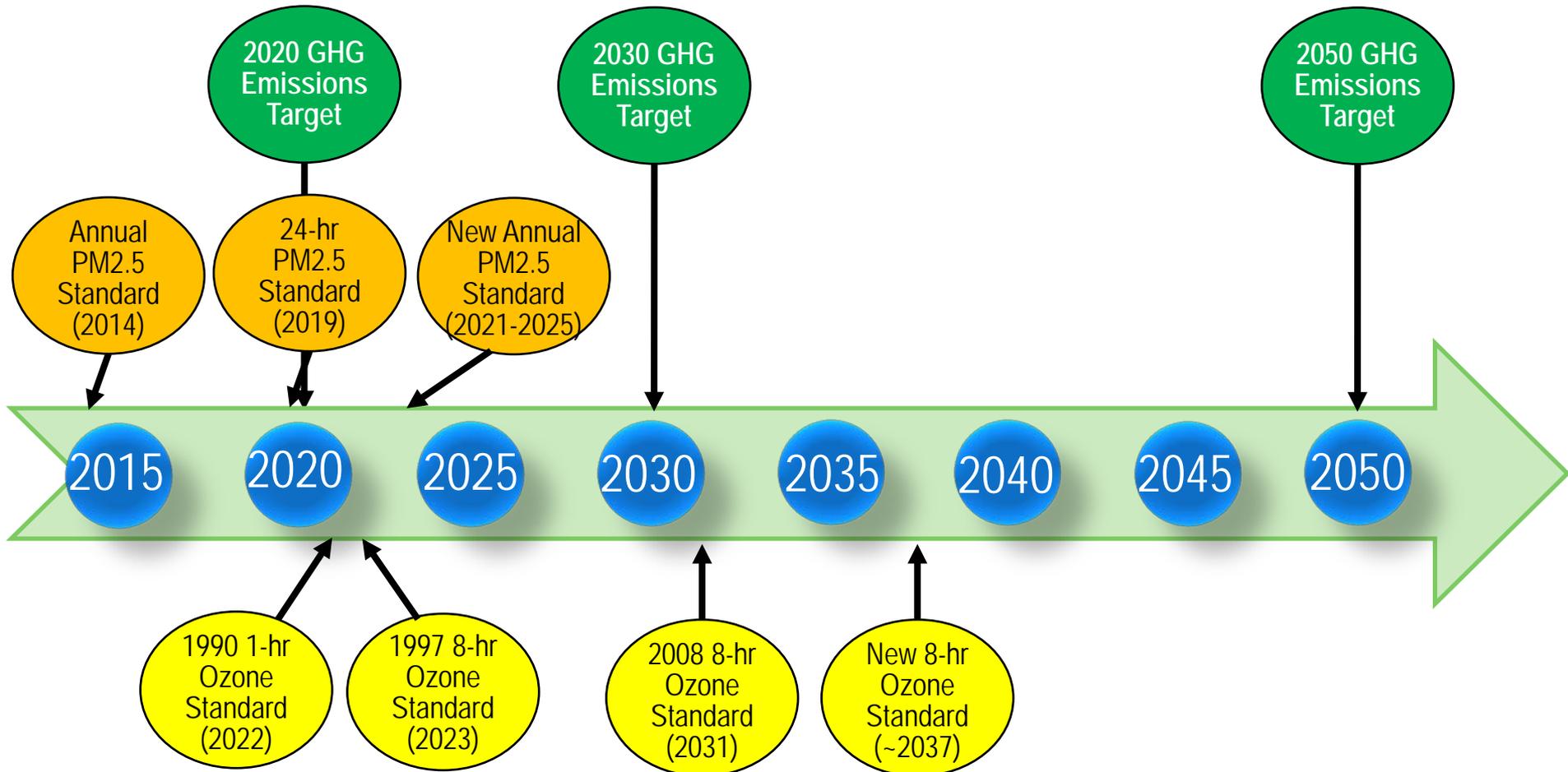
*Assessment of Critical Barriers and Opportunities to Commercialize
Medium and Heavy Duty Truck Technologies in California*

Joint CEC and UC Davis Workshop

Davis, CA

December 3, 2014

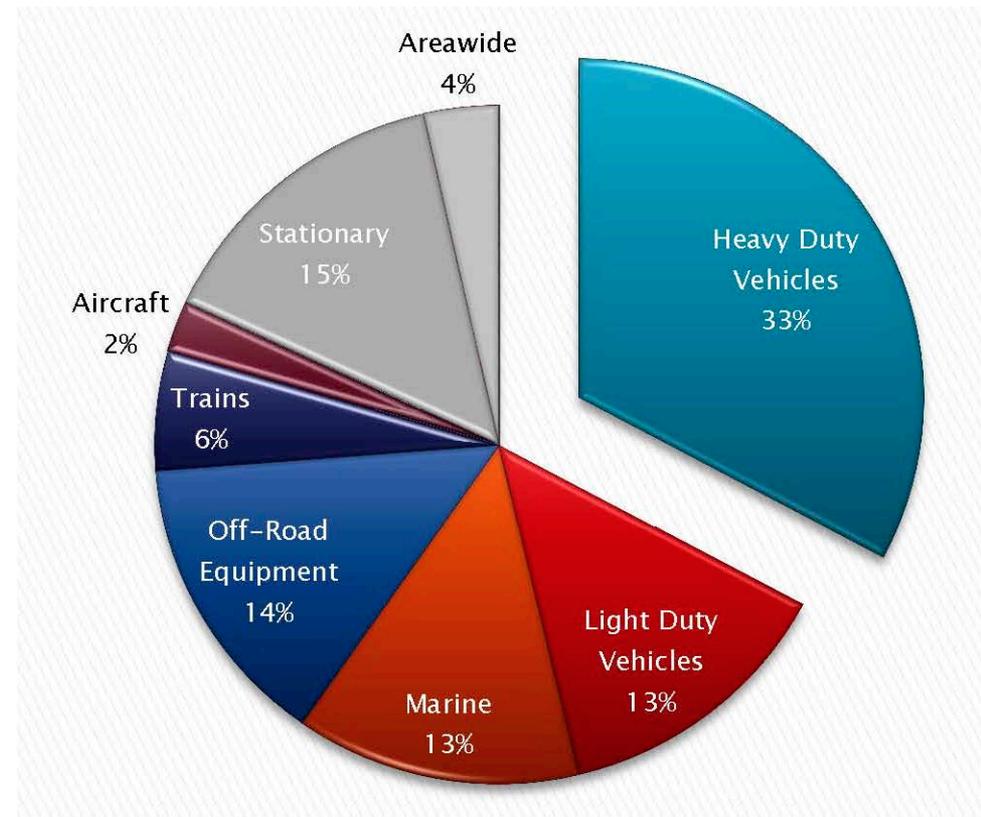
National Ambient Air Quality Standards/ Climate Goals



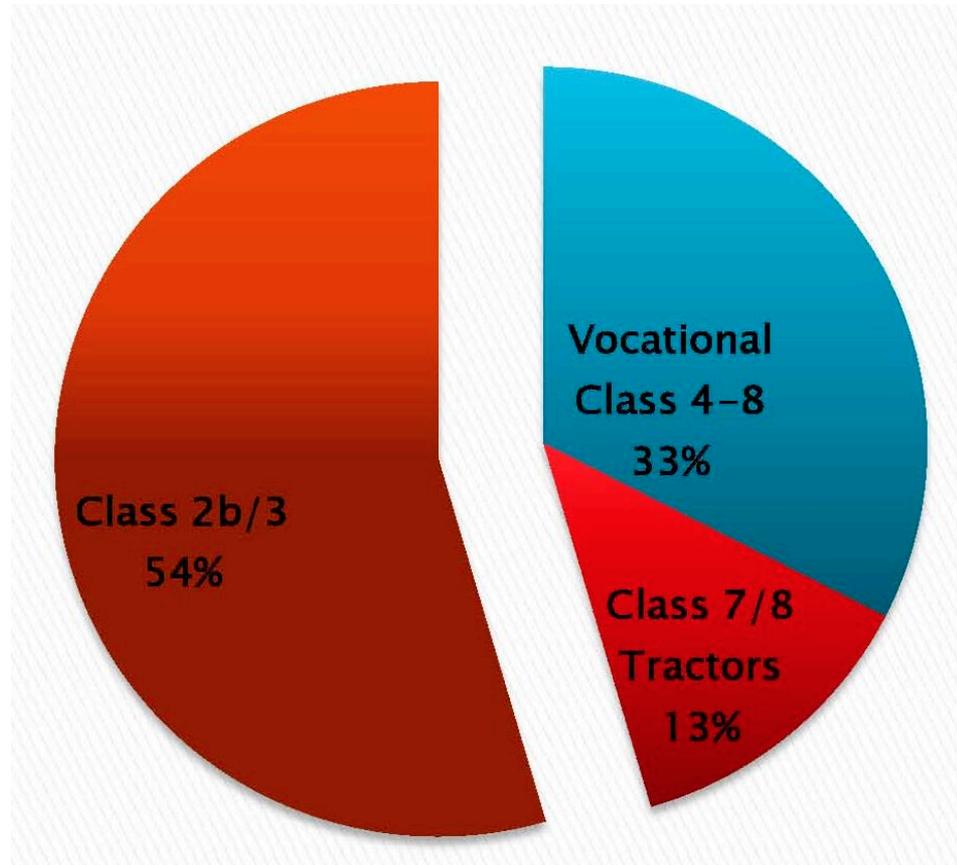
Heavy-Duty Truck Statewide Emissions Contribution

- 33% of Statewide NOx Emissions
- 26% of Statewide Diesel PM2.5 Emissions
- 8% of Statewide GHG Emissions

2014 Statewide NOx Emissions

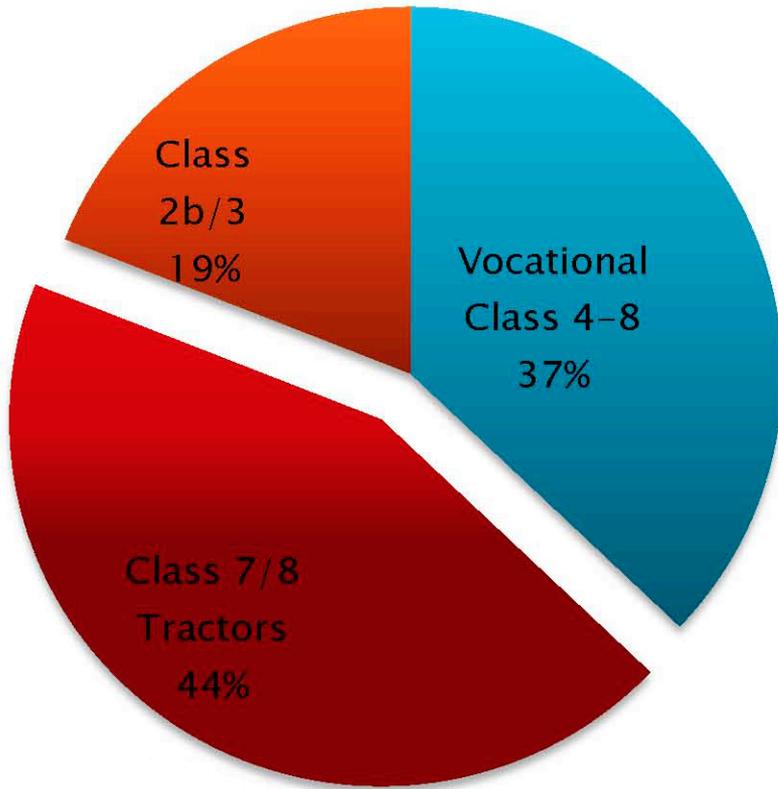


Heavy-Duty Truck by Population in 2014

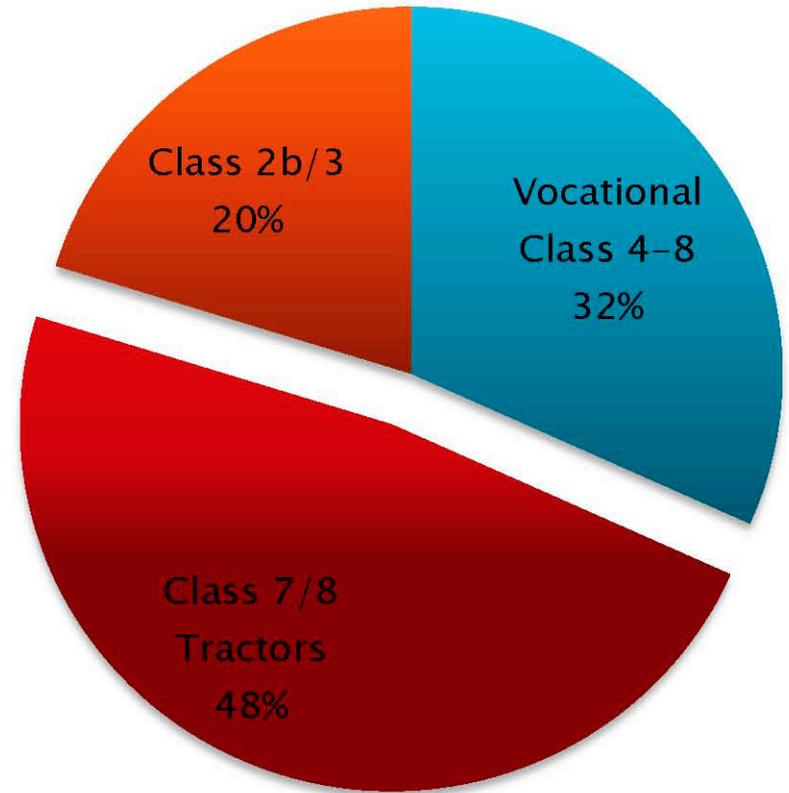


Source: CARB (April 2015)

Heavy-Duty Truck Emissions in 2014



NO_x Emissions



CO₂ Emissions



Fuel Efficiency and Greenhouse Gas Emissions Standards

Fuel Economy and GHG Emissions Standards for Medium and Heavy-Duty Vehicles (Phase I)

- U.S. EPA Final Rule – Sept. 15, 2011
- CARB Adoption – Dec. 12, 2013
- Model Years 2014 – 2019
 - Line Haul Tractors (Class 7 & 8)
 - Engine Standards (g/mi and g/bhp-hr CO₂)
 - 10 – 23% Reduction in CO₂
 - Vocational Vehicles (Class 2b – 8)
 - Vehicle Standards (g/ton-miles)
 - 6 – 9% Reduction in CO₂
 - Pickups & Vans
 - Fuel Efficiency Standards
 - 12 – 17% Reduction in CO₂

Proposed Fuel Economy and GHG Emissions Standards for Medium and Heavy-Duty Vehicles (Phase 2)

- Proposed Rule – July 13, 2015 (Published in Federal Register)
- Model Years 2021 – 2027
- Fuel Efficiency and GHG Limits –
23% More Efficient Compared to 2019 Model Year
- Proposal for Commercial Trailers Beginning 2018
- Pay Back Costs in 2 to 6 Years Based on Fuel Savings
- Fuel Use Reductions – Over 73 Billion Gallons (2018 – 2029)
- \$69 Billion in Savings Over Life of Vehicles Manufactured 2018 through 2029

Reduction in Fuel Use Compared to Model Year 2010 Vehicles

Vehicle Type		Phase 1 by model year		Proposed Phase 2 by model year		
		2014 – 2016	2017 – 2020	2021 – 2023	2024 – 2026	2027+
Heavy-Duty Pick-Ups and Vans*	Gas	Up to 4%	Up to 10%	Up to 12%	Up to 20%	Up to 26%
	Diesel	Up to 7%	Up to 10%	Up to 12%	Up to 20%	Up to 26%
Vocational Trucks*	Engines	Up to 5%	Up to 9%	Up to 11%	Up to 12%	Up to 13%
	Vehicles	Up to 6%	Up to 9%	Up to 16%	Up to 20%	Up to 25%
Combination Trucks*	Engines	3%	6%	8%	9%	10%
	Vehicles	Up to 21%	Up to 23%	Up to 36%	Up to 43%	Up to 47%
Commercial Trailers		NA	Up to 2%**	Up to 4%	Up to 6%	Up to 8%

* Standards Vary Depending on Vehicle Size; Engine Size; Gross Vehicle Weight Rating

** Trailer Standard Beginning 2018 Under Phase 2 Proposal

Source: Table recreated from M.J. Bradley Assoc. Issues Brief (June 25, 2015)

Except from Proposed Regulation

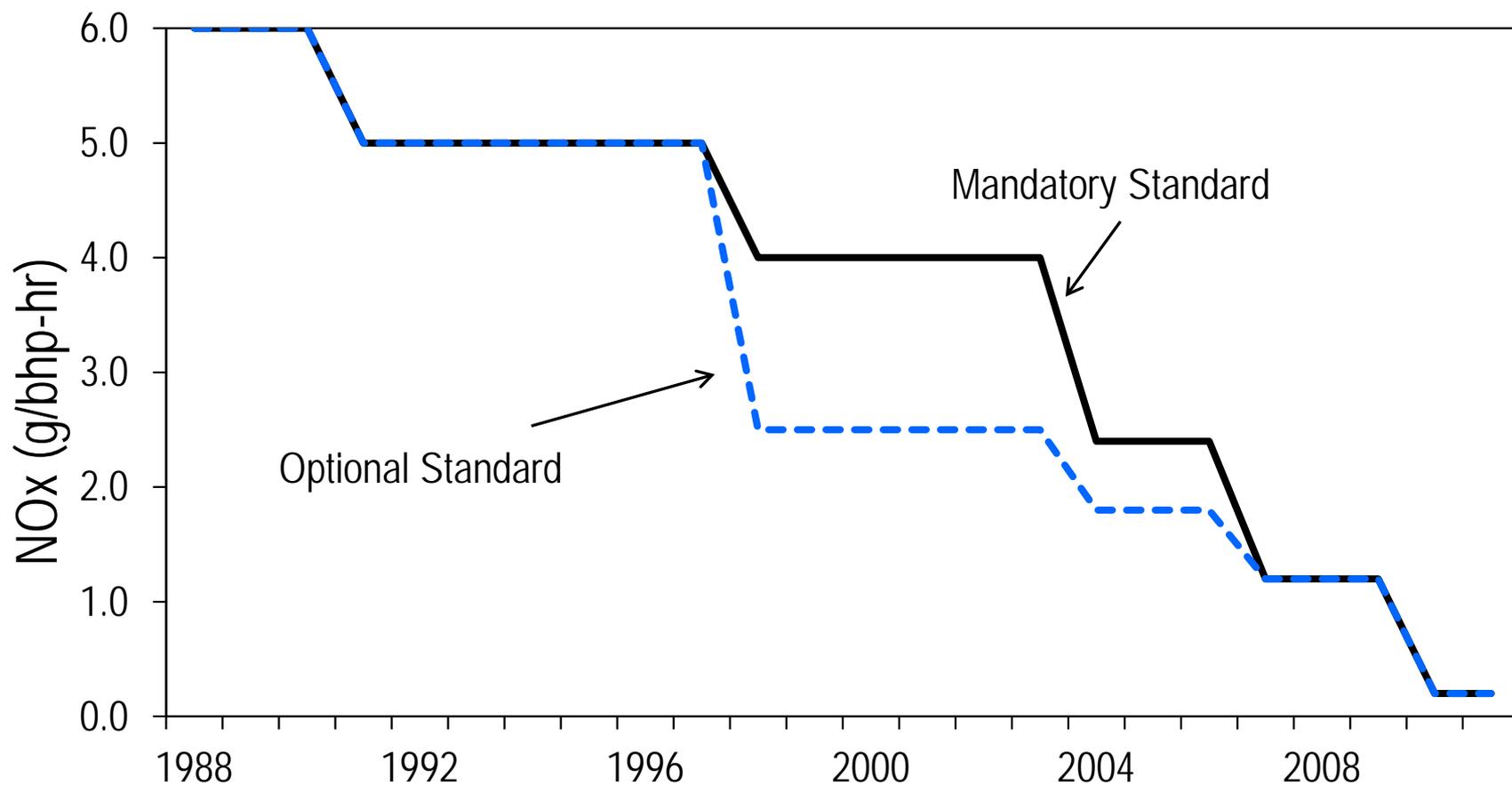
TABLE I-7—PROPOSED FINAL (MY 2027) NUMERIC STANDARDS BY REGULATORY SUBCATEGORY

Regulatory subcategory	CO ₂ grams per ton-mile (for engines CO ₂ grams per brake horsepower-hour)	Fuel consumption gallon per 1,000 ton-mile (for engines gallons per 100 brake horsepower-hour)
Tractors:		
Class 7 Low Roof Day Cab	87	8.5462
Class 7 Mid Roof Day Cab	96	9.4303
Class 7 High Roof Day Cab	96	9.4303
Class 8 Low Roof Day Cab	70	6.8762
Class 8 Mid Roof Day Cab	76	7.4656
Class 8 High Roof Day Cab	76	7.4656
Class 8 Low Roof Sleeper Cab	62	6.0904
Class 8 Mid Roof Sleeper Cab	69	6.7780
Class 8 High Roof Sleeper Cab	67	6.5815
Trailers:		
Long Dry Box Trailer	77	7.5639
Short Dry Box Trailer	140	13.7525
Long Refrigerated Box Trailer	80	7.8585
Short Refrigerated Box Trailer	144	14.1454
Vocational Diesel:		
LHD Urban	272	26.7191
LHD Multi-Purpose	280	27.5049
LHD Regional	292	28.6837
MHD Urban	172	16.8959
MHD Multi-Purpose	174	17.0923
MHD Regional	170	16.6994
HHD Urban	182	17.8782
HHD Multi-Purpose	183	17.9764
HHD Regional	174	17.0923
Vocational Gasoline:		
LHD Urban	299	33.6446
LHD Multi-Purpose	308	34.6574
LHD Regional	321	36.1202
MHD Urban	189	21.2670
MHD Multi-Purpose	191	21.4921
MHD Regional	187	21.0420
HHD Urban	196	22.0547
HHD Multi-Purpose	198	22.2797
HHD Regional	188	21.1545
Diesel Engines:		
LHD Vocational	553	5.4322
MHD Vocational	553	5.4322
HHD Vocational	533	5.2358
MHD Tractor	466	4.5776
HHD Tractor	441	4.3320



Criteria Pollutant Heavy-Duty Engine NOx Emissions Standards

On-Road Heavy-Duty Engine Exhaust Emissions Standards



Optional NOx Exhaust Emission Standards

- Provide Early Emission Targets for Development of Advanced Engine Control Technologies
- Early, Limited Deployment of Engines
 - Evaluate Engine Performance
 - Provide End-User Experience with New Technology
- Enable Funding Incentives for Cleaner Engines

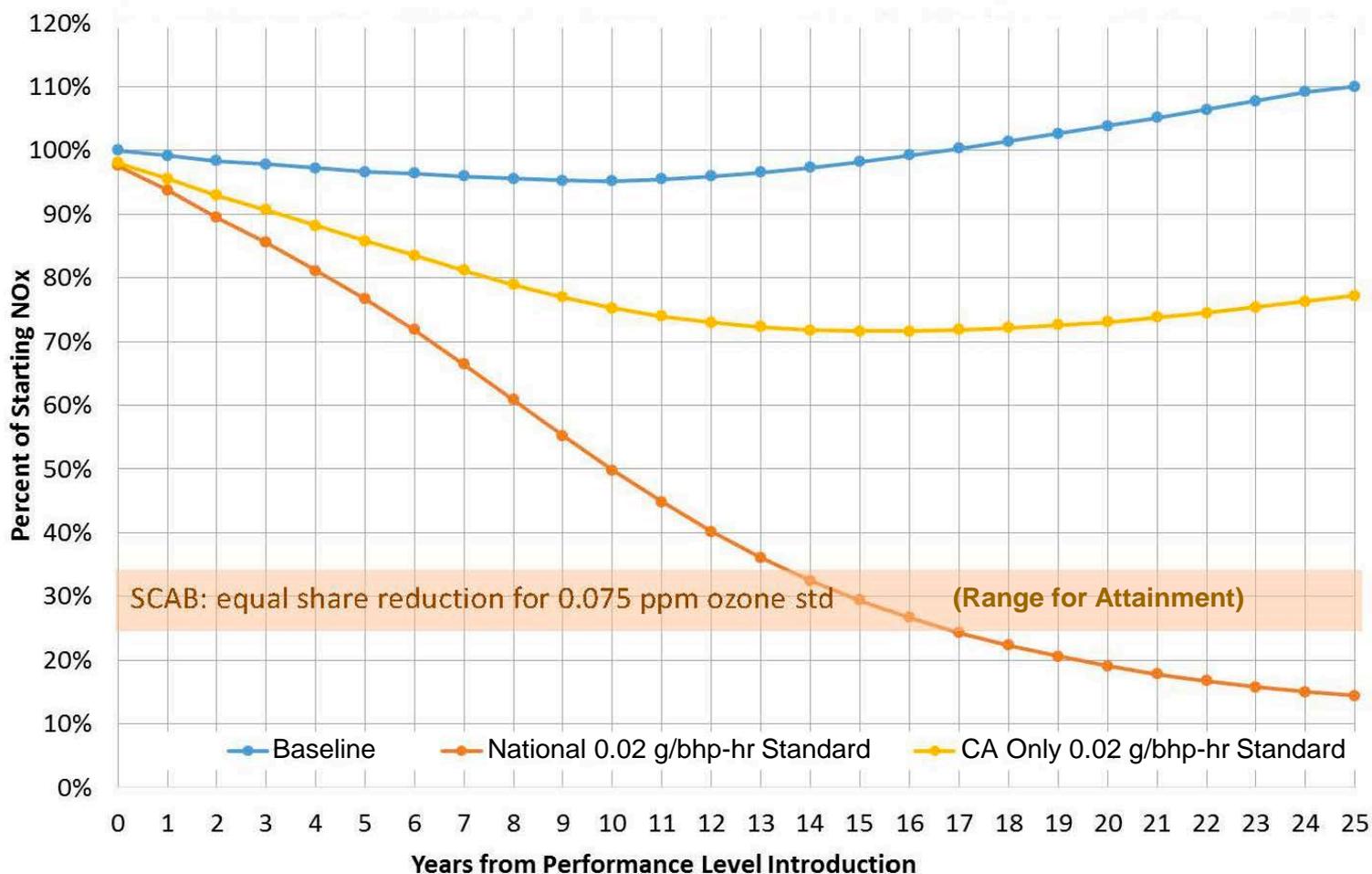
California Optional NOx Exhaust Emission Standards

NOx Exhaust Emissions Level (g/bhp-hr)	Percent Below Current Standard
0.2 (Current)	
0.1	50%
0.05	75%
0.02	90%

CARB Mobile Source Control Strategy Discussion Draft

- Control Strategy Concepts to Meet 2023 and 2031 Ozone Air Quality Standards and Climate Goals
- Near-Term and Longer-Term Strategies Focus on Largest On-Road and Off-Road Mobile Sources
- Will Require Actions at All Levels: Federal, State, and Local
- Petition to U.S. EPA to Adopt More Stringent Emission Standards

Emissions Analysis of a Statewide vs National Introduction of a New Technology



Source: Presentation by Mr. Cory Palmer, ARB at the Symposium on California's Development of its Phase 2 Greenhouse Gas Emission Standards for On-Road Heavy-Duty Vehicles (April 22, 2015)

Going Beyond Current Technologies

- Battery Electric
- Fuel Cell/Hybrid
- Natural Gas/Hybrid
- Extended Range
Catenary/Wayside
- Alternative Fuels/
90% Cleaner than Current
2010 Emission Standards



Cleaner On-Road Heavy-Duty Combustion Engines

- Volvo Engines Certification Level at 0.06 g/bhp-hr
0.8, 12.8, and 16.1 Liter Engines
- Smaller Natural Gas Engines – 0.05 to 0.01 g/bhp-hr
 - 6.8 Liter Engines (242 hp to 362 hp)
- 0.02 g/bhp-hr NO_x Natural Gas Engine Announcement
 - 8.9 Liter Engine – CARB Certification
 - 11.9L Engine Development Underway – Expected Mid-2017

SCAQMD Zero-Emission Truck Projects

- Dedicated Battery-Electric Truck
 - Transpower (4 Trucks)
 - U.S. Hybrid (2 Trucks)
- Fuel Cell Hybrid Electric Truck
 - BAE Systems (Battery-Electric Truck with H2 Fuel Cell Range Extender)
 - Transpower (2 Battery-Electric Truck with H2 Fuel Cell Range Extender)
 - U.S. Hybrid (2 Battery-Electric Trucks with Onboard H2 Generator)
- Hybrid Electric Trucks with All Electric Range
 - Transpower (2 CNG Plug-In Hybrid Trucks)
 - U.S. Hybrid (3 LNG Plug-In Hybrid Trucks)
 - BAE Systems/Kenworth (Battery Electric with CNG Range Extender)
 - International Rectifier (Plug-In Hybrid Electric and Ultra-fast Chargers)
- Overhead Catenary System
 - Vovlo, Transpower, and BAE/Kenworth

