

Controlling Emissions from On-Road Heavy-Duty Vehicles and Engines: A Holistic Approach

Truck and Engine Manufacturers' Perspectives

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**NACAA Fall Meeting
Seattle, Washington
September 26, 2017**

Overview

- **EMA: who we are**
- **HD on-highway energy demand and NOx emissions**
- **EMA members' achievements on HD NOx**
- **The need to better understand remaining HD NOx**
- **EMA's support for a holistic approach for HD NOx**
- **What a holistic approach means to EMA**
- **EMA's work to support HD low NOx**
- **Conclusions**

Who We Are

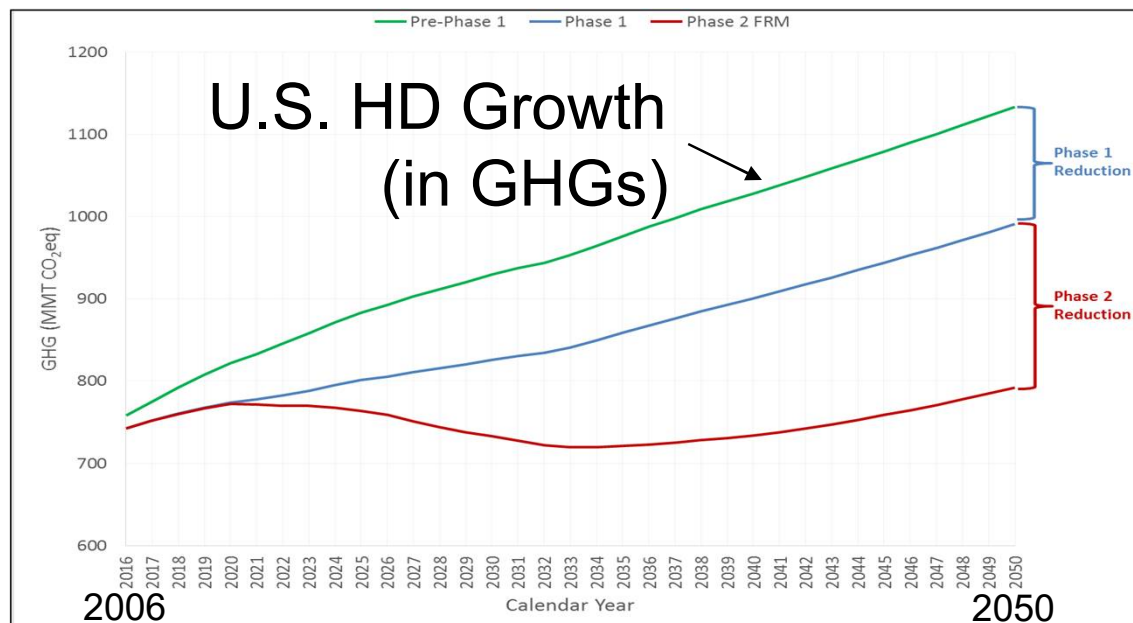
- EMA represents the world's leading manufacturers of engines and heavy-duty trucks (listed on next slide)
- EMA works to promote strategies toward cleaner air and safer highways
 - Advocates for regulations that are technologically feasible and cost-effective and that deliver their intended real-world benefits
 - Sponsors scientific research to improve product performance, emissions and safety, and to support efforts to set feasible, cost-effective and beneficial regulations
- Majority of members' HD trucks are engaged in interstate commerce
- Heavy-duty trucks move 70% of our nation's freight

EMA Members

- AGCO Corporation
- American Honda Motor Company, Inc.
- Briggs & Stratton Corporation
- Caterpillar Inc.
- Cummins Inc.
- Cummins Power Systems
- Daimler Trucks North America LLC
- Deere & Company
- DEUTZ Corporation
- FCA US LLC
- Fiat Powertrain Technologies S.p.A.
- Ford Motor Company
- GE Distributed Power - Waukesha Gas Engines
- General Motors Company
- Hino Motors Manufacturing USA, Inc.
- Isuzu Technical Center of America, Inc.
- Kohler Company
- Komatsu Ltd.
- Kubota Engine America Corporation
- MAN Truck & Bus AG
- MTU America Inc.
- Navistar, Inc.
- PACCAR Inc.
- Scania CV AB
- Volkswagen of America, Inc.
- Volvo Group North America
- Wärtsilä North America, Inc.
- Yamaha Motor Corporation
- Yanmar America Corporation

HD Energy Demand

- HD has the highest growth in energy demand in transportation
- Globally, largest growth by volume
- Combination of increasing VMT and vehicle population growth

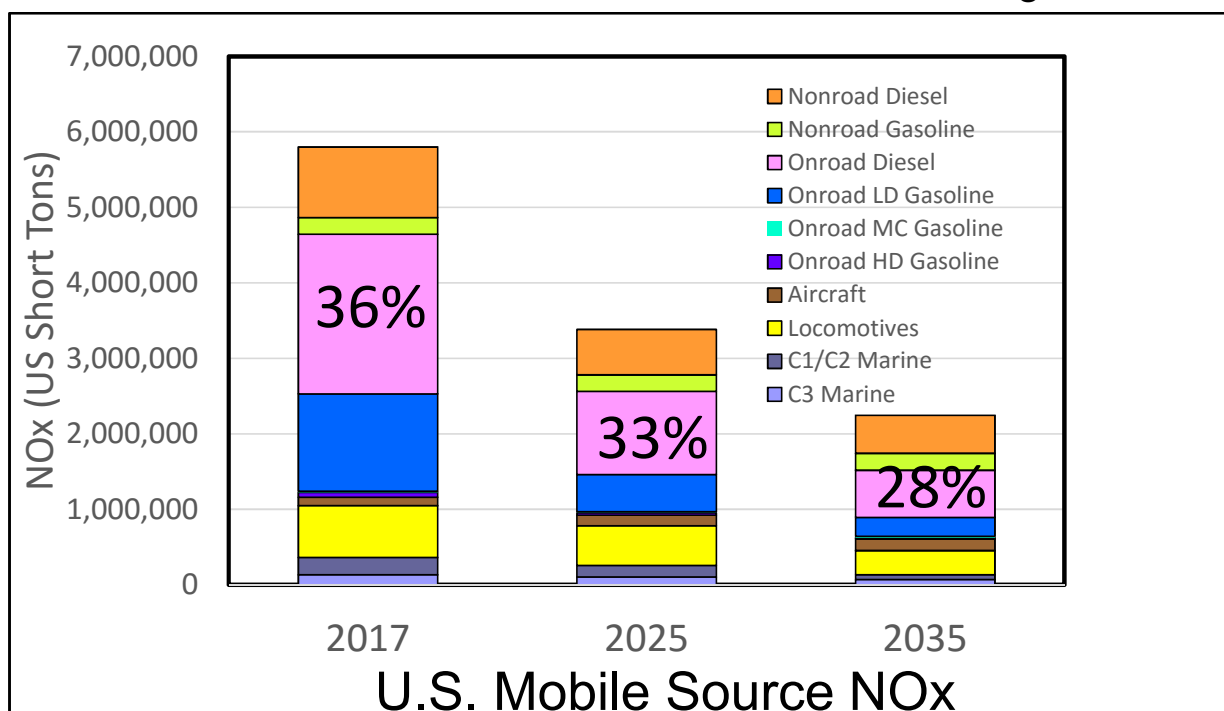


U.S. GHGs with and without HD Phases 1 & 2

Data source: EPA MOVES 2014b (EIA-AEO 2015)

NOx Emissions Currently Attributed to HD

- Despite high growth, new clean diesel engines and fleet turnover have resulted in rapidly decreasing NOx
- NOx from HD is decreasing faster than from other significant sources
- How much faster should HD NOx decrease? What is the goal for HD?



Data source: EPA MOVES 2014b

EMA Members' Achievements on HD NOx

- Achieved >98% HD NOx reductions
 - Some hot-start FTP lab results are now at 0.00 g/hp-hr
 - Certification values must include end-of-life deterioration test results and other compliance margins
 - Those additional factors add regulatory burden
 - But do they properly assess real-world emissions performance?
- No enforcement actions from the HD in-use testing program; compliance is being demonstrated
- Where do we go from here?

The Need to Better Understand HD NOx

- All stakeholders need to better understand the causes of the remaining real-world HD NOx
 - Which engines? What conditions? How significant is it?
- What's most significant? What's most cost-effective?
 - Reducing new engines' NOx at low exhaust temperatures?
 - Detecting and remediating mal-maintenance?
 - Enforcing anti-tampering requirements?
 - Increasing fleet turnover?
 - From the legacy fleet of pre-2010 engines? Pre-2004 engines?
 - Are regulations creating incentives to keep older engines?
 - Ensuring emissions inventory models are validated?

EMA's Support for a Holistic Approach

- Once real-world HD NOx emissions are better understood, essential questions can be answered, and an effective holistic approach can be developed, which could lead to
 - Real-world-focused certification requirements, as opposed to today's lab-based certification
 - Innovative and effective in-use compliance requirements
 - Eliminating burdensome, outdated & ineffective requirements; such as:
 - Excessive lab testing to estimate end-of-useful-life emissions
 - Streamlining OBD requirements
 - A piecemeal approach that simply tightens laboratory-based standards and other existing requirements will result in significant new costs, but won't achieve real-world emissions benefits

What a Holistic Approach Means to EMA

- A holistic approach means synthesizing all program elements into a complete and long-term national program
 - Requires technical feasibility and sufficient lead-time
 - Requires no backsliding on GHGs; lower CO2 = fuel savings to operators
- Advantages of a uniform national program
 - Maximizes environmental benefits nationally and locally
 - Example: 60% of SCAQMD's HD NOx is from interstate traffic
 - Allows manufacturers to offer engines at a lower total cost of ownership
 - Promotes fleet turnover
 - 70-75% of new HD sales replace old products; growth-driven sales are minor
 - Delays in fleet turnover is a big lose-lose; for manufacturers and the environment
 - A piecemeal approach could result in repeated delays

What a Holistic Approach Means to EMA

- Synthesizing all program elements into a complete and long-term program
 - Requires optimizing program elements to address real-world emissions and eliminating outdated and ineffective requirements
 - If it's low temperature operation, focus on technologies and calibrations
 - If it's failing components, consider warranty, but warranty must be balanced with interacting program elements
 - OBD; permissible service intervals; durability and deterioration requirements; in-use compliance requirements; rebuild requirements
 - If it's mal-maintenance or tampering consider other elements
 - Inspection and Maintenance
- A complete, long-term program provides the necessary lead-time and certainty for manufacturers to invest toward compliance
 - A piecemeal approach to implementation—a “phase-in”—does make sense
- But a piecemeal approach to program development creates constraints
 - Example: mandatory extended emissions warranties could undermine the introduction of advanced technologies

EMA's Work to Support HD Low NOx Program Development

- EMA is actively engaging in CARB's HD Low NOx Workgroups and is sharing technical information with EPA and CARB
- EMA is investing more than \$6M in 2017-2019 for HD NOx technical work
- EMA is providing in-house and contracted data and analysis
 - To update inventory models to reflect real-world
 - To assess warranty costs for balancing with other program element costs
- EMA is collecting and analyzing in-use data
 - To identify vehicle and engine operations that contribute most to real world emissions
 - To inform commonsense updates to certification duty cycles
 - To consider innovative in-use compliance concepts
 - Example: leverage on-board emissions sensors and telematics
 - Modernize OBD to significantly decrease burden where OBD is not effective
- EMA is investigating low NOx measurement issues
 - How robustly can anyone measure zero in the lab? And in-use?

Conclusions

- Manufacturers have achieved >98% reductions in HD NOx
- HD engines are compliant and already are achieving essentially zero NOx emissions over a range of engine operating conditions
 - We need to examine that range
- We believe additional real-world HD NOx reductions can be achieved without undermining GHGs
 - However, they must be cost-effective
 - What would 90% of the last 2% cost?
- Once real-world HD NOx is better understood, essential questions can be answered, and an effective holistic approach can be developed
- A holistic approach means synthesizing all program elements into a complete and long-term national program
- EMA is committed to working with the agencies and other stakeholders, and is investing significant resources to address HD NOx