Consensus Study Report
HIGHLIGHTS
October 2019

Reducing the Fuel Consumption and Greenhouse Gas Emissions of Medium- and Heavy-Duty Vehicles, Phase Two: Final Report

Medium and heavy duty vehicles (MHDVs)—including tractor trailers, delivery trucks, utility vans, and buses—account for approximately 22 percent of U.S. transportation energy consumption and greenhouse gas (GHG) emissions. The fuel consumption of MHDVs has only recently begun to be regulated at the federal level. To provide scientific and technical advice on MHDV efficiency, the Energy Independence and Security Act of 2007 mandated the Secretary of Transportation sponsor a series of National Academies' studies on the technologies and costs for improving fuel efficiency in MHDVs. The goal of these studies is to provide periodic advice on establishing fuel economy metrics and standards that are appropriate, cost-effective, and technologically feasible for commercial MHDVs.

This is the final report of the second study in the series. The study issued an interim report in 2014 that focused on technologies and standards for a 2018-2027 timeframe and provided guidance for the 2016 National Highway Traffic Safety Administration's Phase II Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles. This final report covers an even broader range of technologies and issues focused on the 2022-2030 timeframe and beyond.

PROMISING VEHICLE TECHNOLOGIES

The two most widely used conventional platforms for MHDVs are compression ignition (CI, i.e., diesel) and spark ignition (SI) engines. Diesel engines are presently the most efficient engines for MHDVs, with the Department of Energy's SuperTruck initiative on track to demonstrate 55 percent peak engine efficiency within the next few years. However, SI engines also continue to evolve and improve, with the potential to reach more than 40 percent peak efficiency while still meeting stringent emissions criteria. Both of these technology pathways are well-suited to renewable fuels such as ethanol and biodiesel or lower-carbon fuels such as natural gas and propane. Experimental and modelling results suggest that the efficiency of SI engines could exceed the Phase II regulatory requirements depending on the extent that advanced technologies for passenger vehicle engines are adapted to MHDV gasoline engines.

Recommendation: As SI engines continue to be improved, NHTSA and EPA should reassess the future balance in MHDVs between SI and CI, and the reductions in GHG and fuel consumption that might be achieved with a more challenging efficiency requirement for SI engines, including an optimized low-carbon or renewable fuel.

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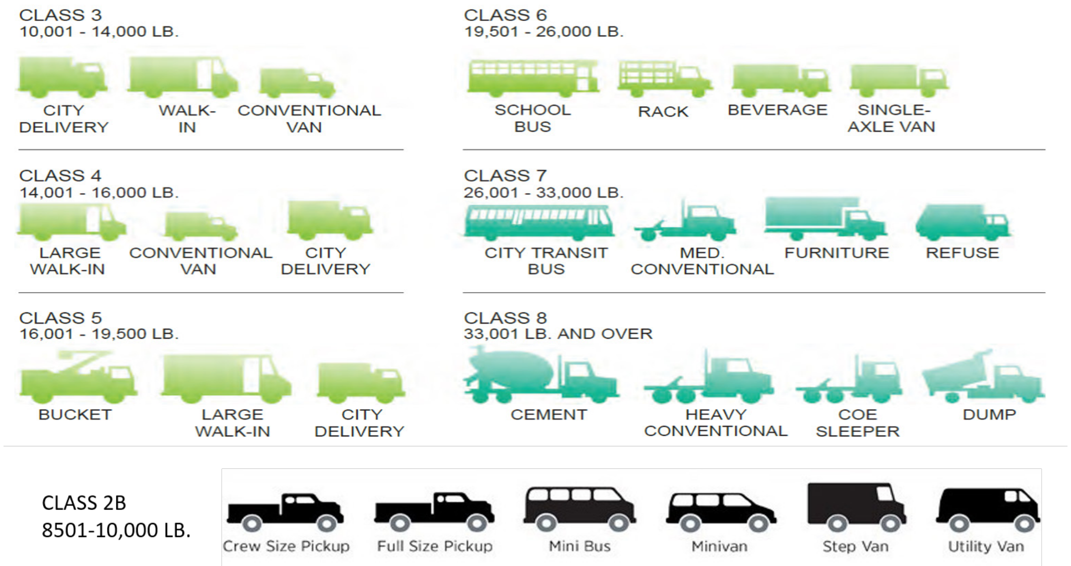

Size and weight classes of medium and heavy duty vehicles. SOURCE: National Petroleum Council (2012) and AFDC (2012).

New fuel and power source options may be needed to achieve significant further progress in reducing fuel consumption and GHG emissions from MHDVs over the next couple of decades. Commercial vehicle efficiency and tailpipe emissions can be improved using electrified powertrains, including hybrids and battery electric vehicles. Several international light-duty vehicle manufacturers and Tier 1 battery suppliers are projecting costs for plug-in hybrid-electric or battery electric vehicle battery packs that will achieve \$120/kWh by 2020 and \$100/kWh or less by 2025. In 2027 and beyond, stop-start technology applications are expected to have payback periods that would make them attractive to vehicle owners and operators in many applications. However, it is important to consider the entire life cycle of a proposed power source to avoid negative unintended outcomes. For example, the direct tailpipe GHG emissions associated with electric medium and heavy duty vehicles are zero – however if the electricity used to power such vehicles is produced using a substantial share of coal, the life cycle GHG emissions could be higher than petroleum-fueled technologies that directly emit GHGs.

Recommendation: NHTSA, in coordination with EPA, should evaluate and quantify the life cycle GHG emissions and fuel consumption of all fuels and technologies whose use could contribute to meeting a third[1] phase of standards. NHTSA and EPA should consider them in developing a third phase of regulation, in order to best accomplish overall goals. It will be critically important to incorporate a life-cycle perspective in those instances where some fuel-technology pathways' life-cycle emissions may lead to an increase, rather than a decrease in emissions.

Waste heat recovery (WHR) may offer cost-effective fuel savings, with some approaches improving engine efficiency by up to 4 percent. Expected progress in WHR technology suggests this technology will see increasing penetration in Class 8 freight trucks.

Recommendation: Industry and government should continue to research, develop, and apply waste heat recovery systems where technical and economic considerations are reasonable to capture this opportunity to reduce fuel consumption.

IMPROVING FREIGHT MOVEMENT EFFICIENCY

There are many ways to improve energy efficiency and reduce GHG emissions in freight transportation. However, the current regulatory structure, which focuses on fuel consumption and GHG emission standards, does not appear to have the flexibility to address new fuels and methods. For example, increases in MHDV size and weight standards could reduce fuel consumption, but the authority to make such changes lies with another agency not part of the rulemaking process. Taking advantage of these opportunities will require action and leadership by

[1] Phase III refers to any further revision to the regulatory regime that might occur after 2027.

federal, state, and local governments, and by private industry.

Recommendation: NHTSA should also coordinate with EPA to engage other agencies in the rulemaking process, such as DOE, the Federal Motor Carrier Safety Administration (FMCSA), and the Federal Highway Administration (FHWA), who have authorities that can facilitate commercialization of low carbon fuels and more efficient freight movement methods. NHTSA in cooperation with EPA should evaluate how incentives or other regulatory provisions can be incorporated to facilitate implementation of fuels and freight movement approaches that lie outside of NHTSA and EPA authorities.

DEVELOPING FUTURE REGULATORY FRAMEWORK

NHTSA and the EPA currently lack reliable data on real world vehicles that can be used to establish a credible regulatory baseline. This information is essential for evaluating the effectiveness and success of the regulatory program and identifying future regulatory priorities and directions.

Recommendation: NHTSA, in concert with the EPA, should commit resources to collecting real world fuel consumption and GHG emissions data from a robust and representative sample of pre-control trucks and for each model year subject to the Phase I and II standards, with priority given to those categories of trucks with the greatest fuel consumption. These data can be used to establish a regulatory baseline that can be used to evaluate program effectiveness and future regulatory priorities.

An effective method of determining whether trucks currently in use are meeting fuel consumption and emission standards does not currently exist. This information is necessary in order to identify opportunities, reduce costs, and improve the effectiveness of the program.

Recommendation: NHTSA and EPA should develop an effective in-use compliance method that would allow the overall performance of the regulatory program to be quantified, identify whether groups of in-use trucks may not be in compliance, and provide insight into truck operating conditions where fuel consumption of future trucks could be further reduced.

INTERIM EVALUATION

Given the long time period during which NHTSA's Phase II regulations on fuel consumption will be in effect (through model year 2027), a midcourse evaluation would help determine whether any adjustments may be appropriate in future rulemakings. This evaluation would survey the implementation progress of the Phase II regulations and note any new developments in the availability or feasibility of relevant technologies.

Recommendation: An interim evaluation should be conducted for MHDVs in the 2021-2022 time period, focusing on adjustments to and preparations for future revisions to the regulations.

2030 AND BEYOND

Implementing new propulsion technologies, low carbon fuels, and more efficient freight operations could reduce GHG emissions beyond what is achievable from improving the efficiency of combustion engine MHDVs. Because of the long lead time needed to develop such advanced technologies and strategies, planning for such measures must begin well before the target dates for implementation. If ambitious national GHG emission reduction and fuel economy goals are established for the 2050 timeframe, the commercialization and deployment of substantially different technologies may need to start as early as 2030.

Recommendation: NHTSA, in cooperation with the EPA, should establish what MHDV GHG and fuel consumption reductions need to be achieved in the 2030 to 2050 timeframe, consistent with national goals and international agreements to which the United States is a party.

Recommendation: NHTSA should coordinate with the EPA to identify a portfolio of technologies and options that could achieve national GHG emission and fuel-economy goals for the 2030 to 2050 timeframe and to identify the research, planning and preparation needed to commercialize and implement such technologies and options in the relevant timeframe.

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