Rigorous National Fuel Economy and Climate Pollution Standards for Commercial Trucks and Buses will Strengthen Our Energy Security and Create Jobs, Reduce Pollution, Foster Innovative Cleaner Technologies, and Save Truckers and Shippers Fuel Costs

January 2014

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Acknowledgements

The authors wish to express their sincere gratitude to all those who contributed to the development and refinement of this white paper, with special thanks to Ramon Alvarez, Mark MacLeod, and Vickie Patton.

Environmental Defense Fund

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Executive Summary

This white paper recommends essential elements for a rigorous Phase 2 greenhouse gas and fuel economy program for large trucks and buses and other heavy-duty vehicles. In a June 2013 speech about the pressing need to address climate change, President Obama acknowledged the importance of building on the first-ever standards for heavy-duty trucks and committed to strengthening fuel economy and greenhouse gas emission standards for post-2018 vehicles, stating: "in the coming months we'll partner with truck makers to do it again for the next generation of vehicle."[1] The President's Climate Action Plan calls for standards that continue to reduce fuel consumption through cost-effective technologies that will increase the efficiency of shipping goods across the United States.[2]

The impacts of extreme weather exact a heavy toll on our families and communities from the ravages of Hurricane Sandy along the shores of New Jersey and New York to devastating flooding in the Colorado Rockies. Indeed, the Fifth Assessment Report of the Intergovernmental Panel on Climate Change concluded in 2013 that "[w]arming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased."[3] President Obama recognized these impacts as the driving force behind his Climate Action Plan: "that science, accumulated and reviewed over decades, tells us that our planet is changing in ways that will have profound impacts on all of humankind."[4]

Robust actions are needed in every sector of our economy to mitigate the greenhouse gas emissions that contribute to these public health and environmental harms. The transportation sector is responsible for 28 percent of our nation's carbon pollution – second only to the power sector.[5] And freight movement is the largest growing source of greenhouse gas emissions and fuel consumption in the United States – despite historic first-ever fuel economy and greenhouse gas standards finalized by the Obama Administration in 2011.[6]

Further improving the efficiency of the medium and heavy-duty sector is one of the most impactful steps that can be taken in the short term to curb climate pollution and reduce our nation's oil consumption, while driving innovative technologies that will stimulate economic growth and create high-quality domestic jobs.

To achieve meaningful results, a rigorous Phase 2 program should:

1. Promote the deployment of the full range of cost-effective existing and advanced technologies to achieve absolute reductions in emissions from the heavy-duty sector by 2025 (over 2010 levels).
2. Adopt rigorous methane standards to address emissions from the vehicle and fueling systems.

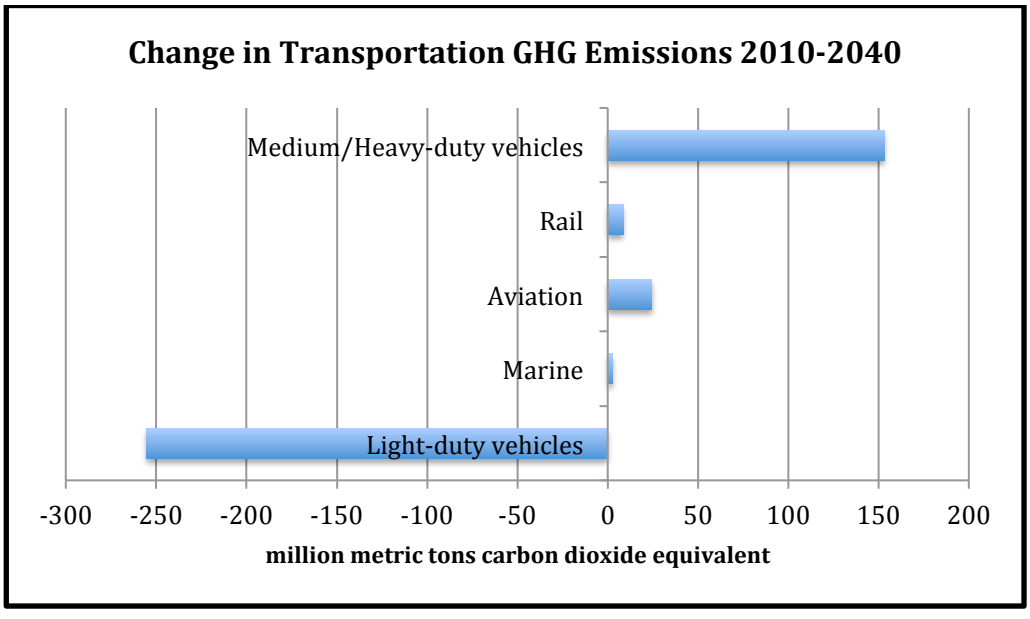
3. Adopt meaningful performance based standards for trailers to maximize emissions reductions and fuel efficiency.
4. Address hydrofluorocarbon ("HFC") emissions from refrigerated trucks and trailers.
5. Provide transparent emissions and fuel economy information to consumers through labeling and online resources.

I. Establish a Phase 2 program that will deploy the full range of cost-effective existing and advanced technologies to achieve absolute reductions in GHG emissions from the medium- and heavy-duty sector by 2025

Heavy-duty GHG emissions estimated to grow by 40 percent

Existing greenhouse gas and fuel economy standards for light-duty vehicles will significantly reduce fuel consumption and climate emissions from these vehicles over the next 20 years, achieving reductions of more than 250 million metric tons below 2010 levels (Figure 1).[7] Emissions from the medium- and heavy-duty fleet, however, continue to rise despite first-ever fuel efficiency and greenhouse gas standards ("Phase 1") finalized in 2011 by the Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA). Current U.S. Energy Information Administration projections show medium- and heavy-duty GHG emissions increasing by more than 150 million metric tons – an additional 40 percent – by 2040, due primarily to an increase in miles traveled (Figure 1).[8] Unchecked, emissions from these vehicles will grow from 22 percent of transportation-related emissions today to more than 30 percent in 2040.[9]

Figure 1



Source: Annual Energy Outlook 2013

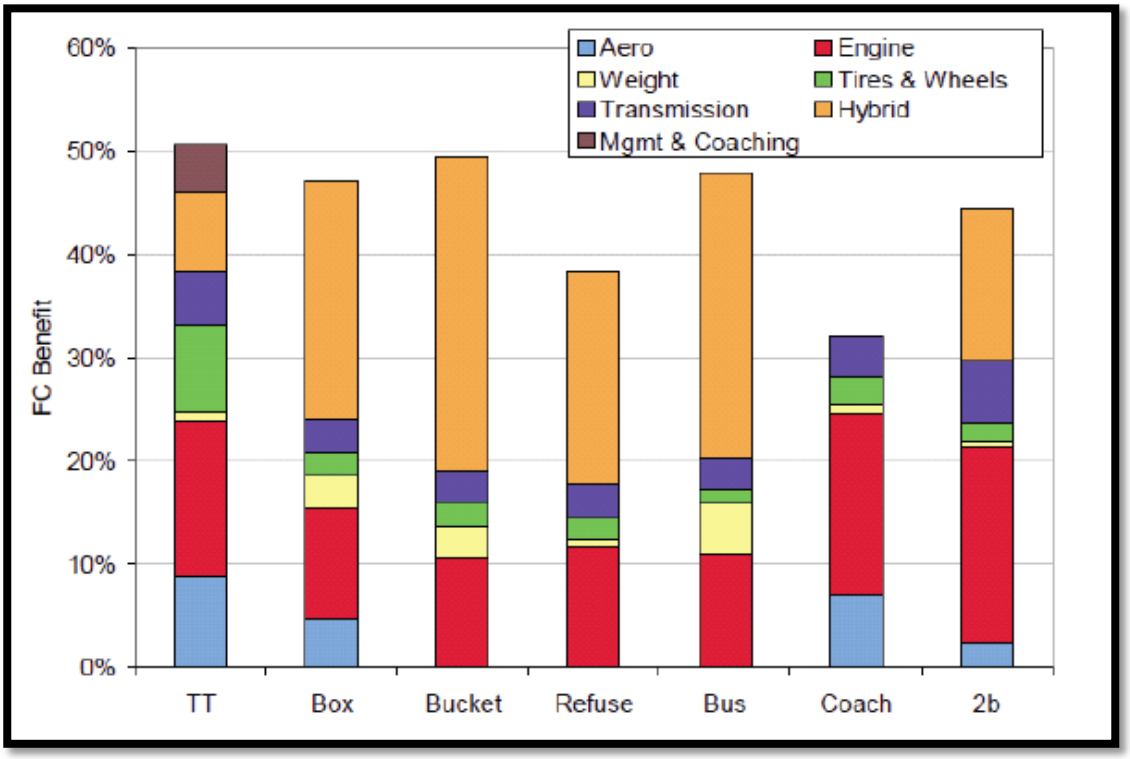
A rigorous Phase 2 program can put trucks on a path to absolute GHG emissions reductions

A rigorous Phase 2 program could fundamentally alter the path of medium- and heavy-duty GHG emissions by delivering absolute reductions over 2010 levels by 2025 and even greater reductions by 2040 as the fleet turns over. To achieve this, the Phase 2 program must fully mobilize existing modern technologies and drive the development and deployment of advanced technologies.

The list of efficiency technologies for the medium- and heavy-duty market is long and well known. It includes downsized engines, engines with waste-heat recovery, hybrids, advanced transmissions, aerodynamic packages, lightweight materials and more. Some of these technologies are on highways today and others are still in the development and testing phase. But to make meaningful reductions in freight climate pollution, each one of these technologies will be needed.

A 2010 National Academy of Sciences' National Research Council study (hereafter "NRC report") assessed current and future technologies for reducing fuel consumption from heavy-duty vehicles.[10] The study estimated that, combined, the included technologies are capable of a 40-50 percent reduction in fuel consumption over 2008 levels in the 2015-2020 timeframe. Figure 2 below from the NRC report summarizes 2015-2020 new-vehicle potential fuel-saving technologies for seven vehicle types: tractor trailer (TT), Class 3-6 box (box), Class 3-6 bucket (bucket), Class 8 refuse (refuse), transit bus (bus), motor coach (coach), and Class 2b pickups and vans (2b).

Figure 2: "Aggressively deploying new technologies can reduce fuel consumption by 40 to 50 percent for most vehicle classes in a 2015 to 2020 time frame."[11]



Source: NRC (2010) Figure S-1.

The Phase 1 standards, which apply to model years 2014-2018 engines and vehicles, are based on only some of the available technologies examined in the NRC study, and do not require full fleet-wide penetration of those technologies. For example, Phase 1 did not establish standards for trailers, a key opportunity to reduce total tractor-trailer fuel consumption and emissions. As a result, the Phase 1 standards will result in an estimated 13 percent reduction in fleet-wide fuel consumption over a 2010 baseline. These fuel savings will reduce carbon emissions by more than 76 million metric tons per year in 2030 over business as usual.[12] While these reductions are a meaningful first step, these standards will **still allow for an estimated 40 percent increase in net emissions by 2040** given the estimated growth in medium- and heavy-duty vehicle miles.[13]

In order to achieve absolute emissions reductions by 2025, the Phase 2 standards would need to reflect the efficiency capabilities of the full suite of available technologies included in the NRC study, as well as driving high penetration rates of each technology. Projects like the DOE Supertruck Program have demonstrated that 40-50 percent fuel consumption reductions are entirely feasible in the near term for tractor-trailers.[14]

The Phase 2 program should also reflect new advanced available technologies. There has been significant innovation and progress made since the publication of the NRC study that will allow industry to go beyond those reductions. Phase 2 should reflect technologies like

waste heat recovery that were not included in the NRC study, but that can deliver significant additional GHG emissions and fuel reductions.

By ensuring a sensible compliance pathway that gives companies the time and flexibility needed to comply, the agencies can adopt a bold and innovative program that relies on the full array of modern technologies to fundamentally alter the upward path of medium- and heavy-duty greenhouse gas emissions. A robust program will reduce absolute climate pollution from the freight truck sector while signaling to industry that American ingenuity will be rewarded. It will enable the freight industry – shippers and carriers – to prosper economically while delivering goods more efficiently.

Recommendations

1. Adopt standards that advance the development and deployment of the full array of modern technologies. The agencies should adopt rigorous fuel economy and greenhouse gas standards for all new medium- and heavy-duty vehicles that fully reflect the efficiency gains achievable by leading available technologies. Evaluating the feasibility and capability of all available technologies and developing the most rigorous standards based on those results should be the core of the program's development.

2. Standards should drive innovation across the entire vehicle. The final standards need to be robust enough to mobilize advanced technologies across the freight truck system– including the engine, the transmission, the components, the trailer and the vehicle as a whole.

II. Capture all vehicle-based methane emissions

Natural gas trucks may become a significant part of the new truck market during implementation of the Phase 2 program. President Obama's Blueprint for a Clean and Secure Energy Future (2013) encourages the adoption of heavy-duty natural gas vehicles to help mitigate oil use in heavy-duty vehicles.[15] The President, however, has made clear the importance of "working with the [natural gas] industry . . . to make sure that we're not seeing methane emissions."[16] While the combustion of natural gas results in fewer CO_2 emissions than the combustion of gasoline or diesel fuel in many applications, natural gas vehicles have the potential to leak methane – a potent climate forcer that must be accounted for and addressed in a rigorous Phase 2 program. Accordingly, a rigorous Phase 2 rule must capture all vehicle-based methane emissions by adopting both strong tailpipe and fugitive methane standards. Additionally, the societal benefits of the resulting methane emission reductions should be accounted for in the rulemaking's cost and benefit analyses.

Vehicle-based Sources of Methane

There are three potential sources of methane emissions from natural gas vehicles: exhaust, venting, and leakage.

Exhaust: Exhaust emissions result from methane that leaves the engine unburned and exits the vehicle either through the exhaust tailpipe or engine crankcase. The Phase 1 rule for medium- and heavy-duty vehicles included a tailpipe standard for methane emissions.

Venting: Venting emissions are associated with liquefied natural gas (LNG) vehicle fuel systems. If left unused, LNG in the vehicle's tank and fuel lines will warm and vaporize, increasing the internal pressure of the tank and lines. LNG tanks are equipped with pressure relief valves that vent gas to the atmosphere once the tank pressure reaches a safety limit, usually 230 psi for vehicle tanks and 175 psi for station tanks.[17] Fuel lines that carry LNG between the tank and vaporizer are equipped with similar pressure relief valves.

A major design feature of LNG tanks is the hold time, which refers to the time elapsed between LNG tank refueling and venting. Typical LNG fuel tank hold time is often stated as around one week, if the vehicle is not driven, but venting will not occur if the vehicle is driven every few days.[18] However, anecdotal evidence suggests venting can occur on shorter time frames. For example, Robert Carrick, Sales Manager-Natural Gas, Freightliner Trucks stated during a panel discussion at the 2013 Work Truck Show that "we have never seen a Chart tank last more than four days without venting."[19]

LNG tanks may be manually vented in order to enable refueling. This occurs due to the need to decrease the pressure in the fuel tank prior to taking on new fuel. Simply venting the tank can be more expedient for the drivers than transferring the gas to the station.

Leakage: Leakage emissions result from the failed operation of fuel system components. This type of emissions occurs when there are cracks, holes, or structural breaks in components, or when connections between components are not leak-tight.

While there is evidence concerning potential emissions sources, there is no clear data yet on the quantity of emissions coming from venting and leakage.[20] EDF is working to sharpen understanding of these emissions sources due to our serious concerns about venting and leaks. These emissions warrant focused attention because of the growth potential of natural gas vehicles in the heavy-duty market.

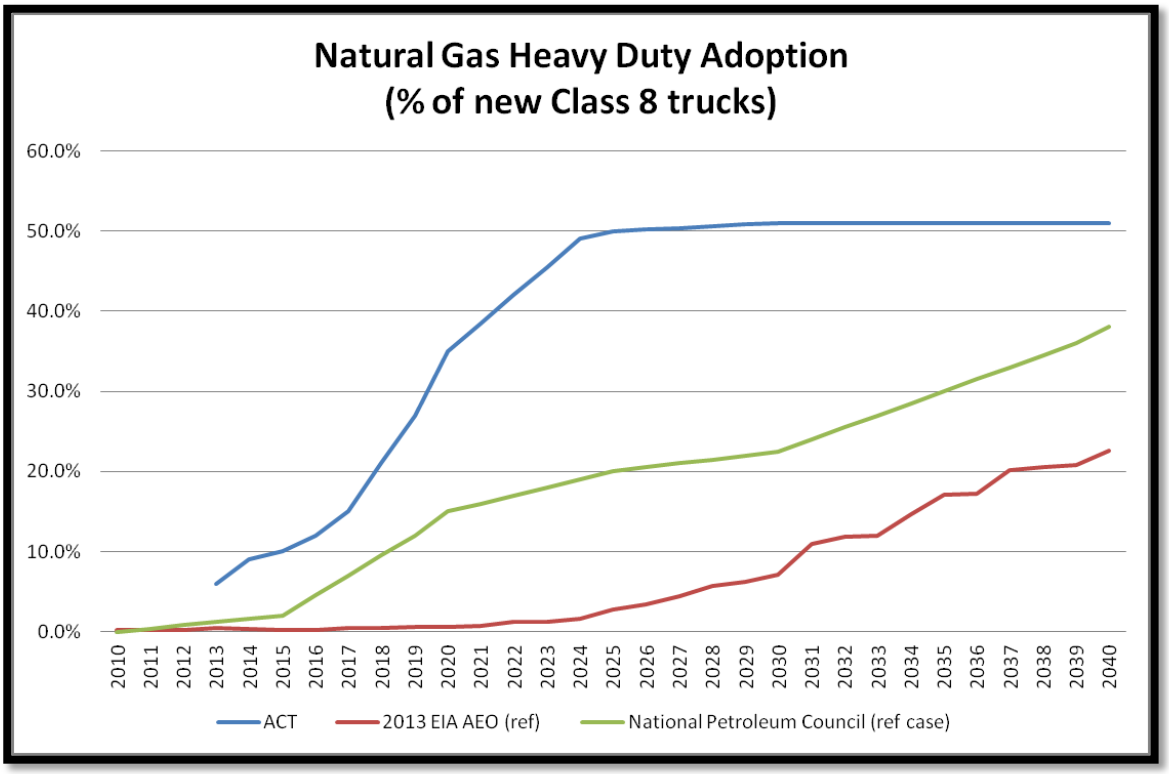
Studies project significant growth in natural gas vehicles in the heavy-duty sector

There are varying projections of natural gas truck adoption in the medium- and heavy-duty marketplace. One study estimates that as many as 100,000 Class 8 natural gas trucks could be sold each year by 2020,[21] an early year of the Phase 2 implementation. Sales of this volume would be a notable shift from current market dynamics where there are just over

2,600 natural gas powered freight tractors in operation today, mostly used in port drayage and regional haul operations.[22]

Figure 3 displays projections from the U.S. Energy Information Agency,[23] National Petroleum Council,[24] and ACT Research.[25] In 2020, the market share projections for Class 8 natural gas trucks are 1%, 15% and 35%, respectively. In 2030, these numbers increase to 7%, 23%, and 51%, respectively. There are several market developments that may lead to adoption rates at the higher end of this range during the time the Phase 2 rules are in effect including, the increased availability of natural gas engines,[26] a national build-up of a fueling infrastructure,[27] and a shrinking payback period.[28]

Figure 3



Natural gas vehicles could also make significant inroads into the vocational market. They already account for an estimated 50 percent of new refuse trucks[29] and a significant number of transit buses.[30] Truck manufacturers at the 2013 Work Truck Show indicated growing demand for natural gas trucks in vocation segments.[31]

Methane's High Global Warming Potential

Methane emissions from natural gas vehicles are especially concerning in light of the potential fleet transition described above. Even relatively small amounts of methane emitted diminish the climate benefit of switching from diesel to natural gas trucks because

methane has a far higher global warming potential than carbon dioxide. Over 100 years, methane is now considered by the Intergovernmental Panel on Climate Change (IPCC) to be at least 28 times more powerful than CO2 – recently adjusted up from a value of 25.[32] However, the commonly used 100-year benchmark fails to reflect methane's full impacts, which are more pronounced over the first few decades after it is emitted (50 years after a pulse of methane is emitted, less than 2 percent of the initial amount remains in the atmosphere). Methane has more than 84 times the climate warming influence of carbon dioxide on a 20-year time horizon – again adjusted up from 72 by the IPCC.[33] Factoring in the climate influence of methane over different time periods provides a more complete picture of the climate impact of natural gas trucks and it is essential that the Phase 2 standards address these concerns. Indeed, a 2012 analysis published in the Proceedings of the National Academy of Sciences indicates that well-to-wheel emission rates as small as 1 percent of gas produced damage the climate for some period of time after switching from diesel to natural gas heavy-duty vehicle fleets – the most stringent threshold for the end uses evaluated in the paper.[34]

Recommendations

1. Establish fugitive methane standard to address vehicle and fueling systems

   The Phase 1 rule for medium- and heavy-duty vehicles included tailpipe standards for methane emissions from truck engines. In order for the Phase 2 rule to make meaningful greenhouse gas reductions from the medium- and heavy-duty fleet, EPA should also adopt a methane standard to address fugitive emissions from the vehicle and fueling system.

   One method to reduce methane leaks could be a low leakage standard. Under the Phase 1 program, EPA established a low leakage standard to reduce HFC leaks from non-vocational air conditioning units using the SAE 2727 leakage scoring system. Under this program, manufacturers must compare their components with a set of leakage-reduction technologies; each leakage-reduction technology is associated with a specific leakage rate. From this, manufacturers can calculate the vehicle leakage rate, which must be kept below a certain threshold, measured either by a percentage or grams leakage per year. This design-based approach could serve as a model for regulating methane leaks from natural gas vehicles and fueling systems.

2. Phase 2 standards should be fuel-neutral

   We encourage the Agencies to set strong fuel economy and greenhouse gas standards for all fuels under the medium- and heavy-duty Phase 2 program. The Phase 1 medium- and heavy-duty rule finalized weaker standards for gasoline engines than for diesel engines. And in the final light-duty fuel economy and greenhouse gas rule, the Agencies provided additional incentives for the manufacture and sale of natural gas vehicles. Both of these approaches provided

unnecessary incentives for particular fuels, creating market distortions that undermine the very environmental improvements the programs seeks to advance.

The Phase 2 program should spur the development of the next generation of trucks that will do our nation's work, while maximizing fuel savings and minimizing environmental impacts. Thus, for the next round of the greenhouse gas rule, we urge the agencies to finalize the most robust standards feasible regardless of fuel.

3. Rulemaking should include the societal benefits of methane reductions

There are important societal benefits to methane reductions and the value of methane reductions can readily be calculated. Executive Orders 13563 (Jan. 21, 2011) and 12866 (Sept. 30, 1993) direct federal agencies to "use the best available techniques to quantify" the anticipated benefits of a regulation. Even if this analysis includes some uncertainty, assigning important benefits a value of zero is unreasonable. Since EPA has readily available methodologies for estimating the benefits of methane reductions, it is obligated to incorporate these benefits into its analysis of the benefits of the Phase 2 rule. EDF urges the Agency to choose the most robust valuation method in the Phase 2 rulemaking that reflects current thinking and research and recognizes methane's role as a potent climate forcer.

III. Improve efficiency of trailers to maximize emissions reductions and fuel economy

Trailers are the primary vehicle for moving freight in the U.S.[35] In 2010, there were nearly 5.8 million commercial trailers registered in the U.S.,[36] and production of trailers by the top 25 manufacturers was up 9.4 percent in 2012, over the year before.[37] Trailers impact the fuel efficiency of trucks through aerodynamic drag, tire rolling resistance and additional weight. It is estimated that there are three trailers in use for every one tractor.[38] Trailers travel fewer miles annually than the tractors that pull them. They also have a longer useful life and slower turnover. Establishing efficiency standards for new trailers will ensure that tractor-trailer combinations see the greatest fuel consumption reductions feasible.

EDF strongly urges the Agencies to ensure the Phase 2 program secures these important reductions. Trailer clean air measures would garner much-needed additional greenhouse gas and fuel consumption reductions in the tractor-trailer fleet by promoting the development and deployment of new trailer technologies. Such measures would also address market barriers like split incentives and consumers' lack of confidence in technology performance.

EPA and NHTSA chose not to regulate trailers under the first fuel economy and GHG rulemaking, citing that the agencies needed more time to reach out to the trailer industry because many are small businesses, and because the trailer industry had not previously been included in these standards. However, EPA and NHTSA confirmed in the Phase 1 final

rule that trailers provide an important opportunity for fuel efficiency benefits and stated that, "[w]hile we are deferring action today on setting trailer standards, the agencies are committed to moving forward to create a regulatory program for trailers that would complement the current vehicle program."[39] EPA and NHTSA should ensure that well designed standards for trailers are included in the Phase 2 rule.

There is significant opportunity for cost-effective trailer efficiency improvements

Significant fuel savings are available from trailers. Even in advance of the Phase 1 rulemaking, EPA and NHTSA were aware that improved trailer efficiency technologies existed that created "the opportunity to reduce fuel consumption and greenhouse gas emissions from tractor trailers by up to 10 to 12 percent for aerodynamics and 3 to 6 percent for lower rolling resistance tires."[40] And even then, EPA and NHTSA recognized that these reductions could be larger than what engine design improvements could provide, and equivalent to the reductions truck design improvements offer.[41]

As demonstrated by EPA's voluntary SmartWay program and California's Heavy-duty Vehicle Greenhouse Gas Reduction Regulation, trailer technologies can make significant fuel and GHG reductions at a reasonable cost. For example, SmartWay trailers employ aerodynamic technologies that are verified to reduce fuel consumption by at least 5 percent and tires verified to make at least a 3 percent improvement. [42] Participation in the SmartWay program has grown from 15 Charter Partners that helped EPA kick off the partnership in 2003, to over 3,000 Partners as of August 2012.[43] As a whole, SmartWay Partners have saved a total of more than 2.3 billion gallons of fuel cumulatively from 2005 through 2011 (all fuel types) – and 23 million metric tons of CO2 equivalent – by using technology and strategies showcased by EPA SmartWay.[44]

California's regulation requires all new tractors and box trailers 53 feet or longer to be SmartWay certified and all existing tractors and trailers to retrofit with SmartWay certified technologies over a phase in period. California found that the timetable for return on investment to implement these technologies on trailers is now as short as eleven months, down from 30 months when the program started in 2008.[45] And the number of companies making aerodynamic devices increased from 5 to 21 between 2008 and 2012 while the average cost of the devices was cut by more than half over the same four years.[46] Over an 11-year equipment lifespan, from 2010 to 2020, CARB staff expects a net savings of approximately $4.3 billion to truck operators because of improved fuel economy.[47] These in-use results from California's program demonstrate the increasing cost-effectiveness of trailer regulation.

Leading fleets are demonstrating that further improvements are achievable and cost-effective today. C.R. England, the largest temperature-controlled carrier in the world, announced in November 2013 that it would be installing TrailerTail® technology from ATDynamics on its latest group of new trailers. According to the company, this move "has the potential to reduce the company's diesel consumption by more than two million gallons

annually."[48] ATDynamics reports that the TrailerTails reduce fuel consumption by 6.6 percent at 65 mph.[49]

ConWay Truck load has upfitted many of its trailers with the UT6 system produced by SmartTruck.[50] This product package improves fuel economy by 7 percent.[51] The manufacture also produces a more advanced aerodynamic package that currently delivers a 10 percent fuel savings.[52]

Well designed standards for Phase 2 will ensure these smart measures and available technologies are broadly deployed. They will also help overcome many of the existing barriers examined below.

Trailer measures are needed to secure emissions and fuel consumption reductions

In the Phase 1 final rule, EPA and NHTSA concurred with a National Academy of Sciences position that trailer regulation can provide fuel savings and GHG emissions reductions that **would otherwise not occur**[53] (emphasis added). The trailer market is complex, and creates many market barriers to the purchase of more efficient trailers. EPA and NHTSA recognize the barrier of a split incentive – because buyers often do not benefit from fuel and emissions saving investments, they have little reason to bear the costs of implementing the technologies.[54] Another barrier is consumers' lack of knowledge and/or confidence in the fuel saving performance of new technologies. The International Council for Clean Transportation (ICCT) commissioned a study in North America that analyzed the existence and importance of barriers through a survey of leading engine and transmission manufacturers, aerodynamic device developers, tractor and trailer builders, truck dealers, fleet operators, shipping companies, and owner-operators. The study found several barriers consistent across all of the stakeholder groups including, 1) lack of credible information; 2) uncertainty around payback time; 3) lack of access to capital to invest in new technologies; 4) questions about reliability of new technologies; and 5) lack of availability of fuel-saving technologies from preferred OEMs or component suppliers.[55] Including trailers in the Phase 2 program can help offset consumer unease by providing unbiased information and verification of fuel efficiency improvements. Regulation will also drive down the costs of fuel-saving technologies while increasing reliability and availability.

EDF fully supports the continued role of the SmartWay program in enabling shippers to choose truck carriers that take additional steps to reduce fuel consumption, such as retrofitting existing trailers with aerodynamic devises. A mandatory, robust trailer regulation, though, is crucial to ensure the greatest efficiency feasible for all new trailers.

Recommendations

1. <u>Include trailer standards in the Phase 2 rule</u>

   EDF strongly recommends that EPA and NHTSA adopt performance-based standards for trailers as part of the Phase 2 fuel economy and GHG emissions

regulation. Such an approach would drive the development and deployment of efficiency technologies and provide regulatory certainty to manufacturers and help alleviate the existing market barriers. ICCT is currently collecting data on the penetration rates and costs of existing trailer technologies. Their analysis could help the Agencies develop a baseline from which to establish a meaningful performance standard.

2. Adopt performance-based standards for box trailers that reflect aerodynamics and weight

   EDF recognizes the diversity of the trailer market and therefore recommends the Agencies establish standards for 53-foot box trailers that reflect the best aerodynamic and light-weighting improvements. Box trailers, or dry van trailers, represent about 60 percent of the trailer market and about 67 percent of new registrations over the last decade.[56] Three companies dominate the manufacturing of box trailers – Great Dane Trailer, Wabash National, and Utility Trailer Manufacturing – producing 79 percent of new van trailers registered in the last 4 years, and 55 percent of all newly registered trailers.[57] While nearly half of all trailer manufacturers are considered small businesses by the Small Business Administration definition, [58] the 3 primary manufacturers of box trailers are not considered small businesses.[59]

   The Agencies could also use innovative measures to incentivize aerodynamic and weight reduction improvements in non-box trailers.

3. Adopt standards for all trailers that reflect rolling resistance technology

   Tires and underbody skirts can be installed on all trailers at a reasonable cost.[60] EDF urges EPA and NHTSA to adopt standards for all trailers that reflect the efficiency improvements of low rolling resistance.

IV. Establish standards for HFC emissions from refrigerated trucks

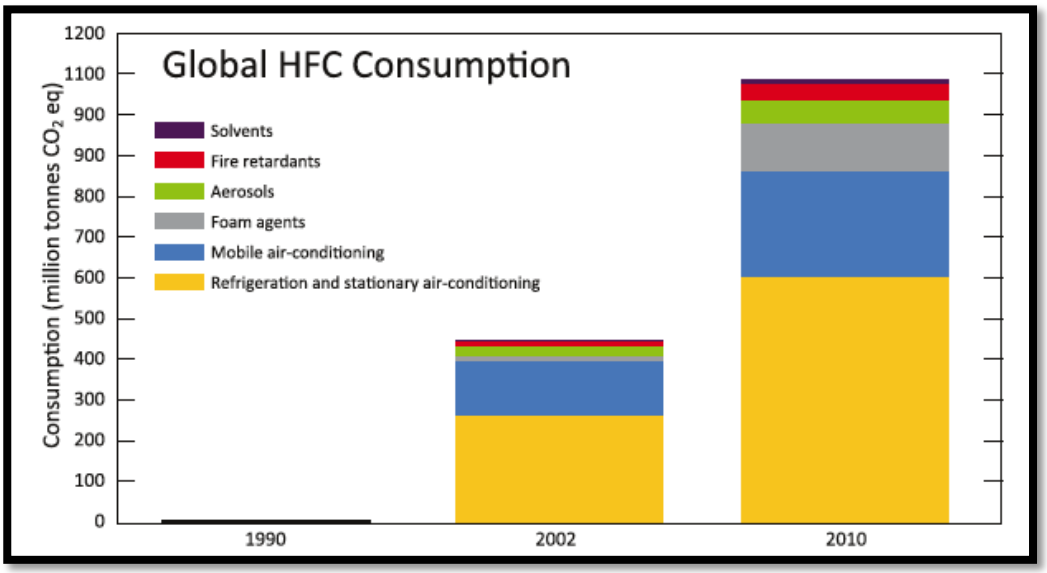
In addition to climate emissions from fuel combustion and methane emissions associated with natural gas vehicles, medium- and heavy-duty vehicles are also responsible for significant hydrofluorocarbon (HFC) emissions. HFCs have very high global warming potentials and long atmospheric lifetimes. In medium- and heavy-duty vehicles, these gases are primarily used as refrigerants, in both air conditioning units in tractor cabs as well as refrigeration in trailers. While EPA's Phase 1 rule addressed air conditioning emissions from non-vocational vehicles, it will be critical for the Phase 2 rule to provide rigorous emissions standards for the largest emissions source – refrigerated transport – and to incentivize replacement of HFCs with low global warming potential (GWP) substitutes.

These actions would support the Obama Administration's Climate Action Plan call for EPA to use its authority under the Significant New Alternatives Policy (SNAP) Program to encourage private sector investment in identifying and approving climate-friendly HFC alternatives and prohibiting the use of the most harmful chemical alternatives.[61]

HFCs are a Growing Contributor to Overall Climate Forcing

Fluorinated gases are manmade compounds with no natural sources. These gases, including HFCs, perfluorocarbons (PFCs), and Sulfur Hexafluoride (SF6) have very high global warming potentials and long atmospheric lifetimes. HFCs have atmospheric lifetimes between 1 – 270 years and GWPs ranging from 140 – 11,700; PFC lifetimes range from 800 – 50,000 years with GWPs of 6,500 – 9,200; and SF6 has an atmospheric lifetime of 3,200 years and a GWP of 23,900.[62] Fluorinated gases are the most potent and long-lived of all the GHGs emitted by human activities.

Figure 4



Source: UNEP (2012)

While fluorinated gases currently represent a relatively small portion of overall GHG emissions (2 percent), they are swiftly growing, and absent rigorous control measures, will pose a significant problem in the future.[63] Overall, fluorinated gas emissions in the United States have increased by about 61% between 1990 and 2011. This increase has been driven by a 249% increase in emissions of HFCs since 1990, as they have been widely used as a substitute for ozone-depleting substances under the Montreal Protocol, primarily for refrigeration. HFC emissions are projected to grow by another nearly 140% between 2005 and 2020 as demands for refrigeration continue to grow and as more ozone-depleting substances are replaced.[64] Figure 4 depicts the similar global growth in HFC use. Unchecked,

in 2050, HFCs could equal 7-19 percent of global CO2 emissions in a business as usual scenario and 18-45 percent of CO2 emissions in the IPCC 450ppm stabilization scenario.[65]

Refrigerated transport is a significant source of high GWP HFC emissions

More than 57 million metric tons CO2e of HFC emissions are attributable to the transportation sector, and of those, over 40 million metric tons come from vehicle air conditioning systems in cars and light trucks. The second largest transportation source of HFC emissions, however, is refrigerated transport in the medium- and heavy-duty sector, accounting for 11.7 million metric tons of CO2e, or more than 20 percent of all transportation-related refrigerant emissions and almost 10 percent of all emissions associated with ODS substitution.[66] HFCs are emitted to the atmosphere during equipment manufacture and operation (as a result of component failure, leaks, and purges), as well as at servicing and disposal events. The most rapidly growing HFC across all sectors, HFC-134a, is used as a refrigerant in the transportation sector in air conditioning units and refrigerated transport.[67]

Table 1

Chemical	GWP
Refrigerant	
R-12	10,900
R-502	4,657
R-507A	3,985
R-404A	3,922
R-410A	2,088
R-22	1,810
R-407C	1,774
R-134a	1,430
R-1234yf	4
R-290 (Propane)	3.3
R-600a (Isobutane)	3
R-744 (CO_2)	1
R-717 (Ammonia)	0
R-728 (Nitrogen)	0

As mentioned above, HFCs are of concern because of their high global warming potential. Historically, the main refrigerant in the transport refrigeration sector was a hydrochlorofluorocarbon (an ozone depleting substance) called HCFC-22, although other ODS were also used (e.g., R-502, CFC-12). As a result of the Montreal Protocol and the phase out of ODS, many equipment manufacturers in developed countries converted to HFCs like R-404A, R-507A, R-410A, R-407C, and HFC-134a in the 1990s. These substitutes have GWPs ranging from 1,430 to over 10,000, as shown in Table 1. By 2010, global market penetration of HFC refrigerants in transport refrigeration equipment was estimated at 40% for ships, 70% for road vehicles, and 95% for intermodal containers, with HFC-134a being the preferred refrigerant in road transport.[68]

Lower global warming potential substitutes are available

Lower GWP substitutes are on the market today and these substances could significantly reduce both near-term and projected future warming. For example, HFO-1234yf, with a GWP of 4, and carbon dioxide (R-744), with a GWP of 1, have both been approved by EPA through its Significant New Alternatives Policy (SNAP) program as substitutes to ODS for use in light-duty vehicles. However, there have been no approvals of lower GWP substitutes for use in heavy-duty applications in the United States.

Alternative technologies like cryogenic (open-loop) systems, secondary loop systems, eutectic places, hermetic/semi-hermetic systems, and cascade systems are also being explored for use in road vehicles. Cryogenic truck and trailer systems cool cargo by injection of stored liquid CO2 (R-744) or nitrogen (R-728, N2) to the cargo space or an evaporator, minimizing environmental impact and noise. In 2007, Norway introduced R-744 refrigerant-based cryogenic systems into the road transport refrigeration market. By 2011, 16% of new refrigerated trucks sold in Norway contained a cryogenic refrigeration system. Cryogenic systems are currently used in other European countries and are being piloted in the United States.[69]

Alternative technologies are also being demonstrated in the U.S.:

- Wabash, Safeway, and ecoFridge are using liquid-nitrogen technology on 22 Safeway trailers. The refrigeration system includes a liquid nitrogen tank stored under the trailer. The nitrogen is converted from a liquid to a gas and sprayed directly into the trailer via a series of valves. A variety of safety features have been included on the trailer to ensure workers are not exposed to low-oxygen levels. The system precools the trailer quicker than conventional coolants. It also warms up slower. In addition to using a lower impact refrigerant, this system has demonstrated carbon dioxide emission reductions of 15 tons per unit per year, as the system doesn't require a diesel-powered cooling unit.[70]

- Carrier – a United Technologies Company – has launched a new refrigeration unit for use on marine vessels that runs on carbon dioxide. The unit is able to cut the climate impact of the refrigeration unit by 35%. John Mandyck – UTC's Chief Sustainability Officer, noted that these savings came about because the company has "been able to match the best in class energy efficiency using CO2" while also "replacing a higher global warming refrigerant." UTC is exploring how it can use the technology in truck trailer refrigeration applications.[71]

Recommendations

1. Adopt HFC standards for refrigerated trailers

   The Phase 2 program should include robust standards for refrigerated truck transport – the second largest source of HFC emissions from the transportation sector. In its discussion of potential requirements in the Phase I standards, EPA identified HFC emissions from refrigerated trailers as a potential source to address in the future: "In addition, refrigerated trailers have opportunities to both reduce the fuel consumption and CO2 emissions of the Trailer Refrigeration Unit (TRU) and reduce GHG emissions through reduced refrigerant leakage."[72]

   The Phase 2 program should include robust low-leak standards for all refrigerated trucks and trailers. The program should also incentivize alternative technologies and replacement of high GWP HFCs with low GWP alternatives.

2. Approve low-GWP alternatives for use in heavy-duty vehicles and refrigerated transport equipment

   Phase 1 standards allow for vehicles to comply with the air conditioning standards by installing leak tight components or by substituting low GWP alternatives. However, there has been no action to expand SNAP approval for low GWP alternatives for use in medium- and heavy-duty vehicles or refrigerated transport, as anticipated by EPA in the final Phase 1 rule.[73] Therefore, EPA should ensure that HFO-1234yf and other low GWP alternative refrigerant (such as R-744) are SNAP approved for use in heavy-duty applications and in refrigerated transport as soon as possible and no later than at the time of the Phase 2 final rule. This will allow for cost-effective reductions in HFC emissions from the heavy-duty sector.

V. Provide transparent emissions and fuel economy information to consumers through labeling and online resources

When faced with the decision about which new light-duty vehicle to buy, consumers are provided with valuable information including city and highway fuel economy, greenhouse gas rating, average annual cost and estimated cost savings over an average vehicle. This information is posted on the window of all new light-duty vehicles sold, and additional information is readily available from EPA's Fuel Economy Guide and other online tools. However, consumers of medium-duty pickup trucks and utility vans – despite the vehicle similarities in use patterns and engine and transmission configurations with light-duty trucks – are not offered any information on fuel economy, emissions or relative costs. Improving the fuel consumption information on 2b and 3 trucks will foster the deployment of cost-effective efficiency technologies. EDF urges EPA to conduct label design and education outreach for Class 2b and 3 vehicles, similar to that conducted as part of the light-duty labeling rule. We also request that EPA and DOT finalize comparable window label requirements for all new 2b and 3 vehicles.

In light of the large population, annual sales and miles travelled of Class 2b and 3 vehicles improved transparency can inform consumer choice about opportunities to improve fuel efficiency, save money and reduce emissions

In 2011, EPA and NHTSA issued a joint final rule establishing new requirements for the fuel economy and environment label posted on the window of all new passenger cars, light-duty trucks, and medium duty passenger vehicles (MDPV). Light-duty cars and trucks are defined as less than 8,500 lbs. gross vehicle weight rating (GVWR) (Class 1 and 2a) and MDPVs are vehicles with a GVWR of 8,501-10,000 lbs., and include large sport utility vehicles and passenger vans, but not larger pick-up trucks (2b).[74] Pick-up trucks and vans with a GVWR of 8,501-10,000 lbs. are also Class 2b but are not considered passenger vehicles and are therefore regulated with medium- and heavy-duty vehicles, and thus are not required to provide fuel economy and environment labels.[75]

The U.S. Energy Information Administration (EIA) estimates that Class 2b vehicles achieved approximately 14.5 – 15.6 miles per gallon (mpg) fuel economy in 2010.[76] Class 2b and 3 trucks and vans were responsible for 12 percent of CO_2 emissions from the heavy-duty fleet in 2005.[77] While their CO_2 emissions are lower than vocational trucks and tractor trailers, Class 2b and 3 pickup trucks and vans have the highest sales volumes, with sales of over 1.3 million units in 2005, or nearly 66 percent of the heavy-duty market.[78] According to data from DOT, in 2002, there were 5.8 million 2b vehicles in use – representing just over half of the total medium- and heavy-duty vehicle population and traveling 35 percent of total medium- and heavy-duty vehicle annual miles.

The large population of 2b and 3 vehicles, their large annual sales volume and the high number of miles they travel annually make 2b and 3s a key opportunity to inform consumers about availability of more efficient technology that cuts fuel costs and reduces pollution

Similar use and configuration to their light-duty counterparts make labels feasible

Despite the definition and regulatory split between light-duty trucks and 2b and 3 trucks, they are very similar in use patterns as well as engine and transmission configurations and emissions control technology. EPA regulates criteria emissions from 2b and 3 vehicles under the light-duty Tier 2 and proposed Tier 3 rulemakings because, "Most are built by companies with even larger light-duty truck markets, and as such they frequently share major design characteristics and potential emissions control technologies with their LDT counterparts."[79] In fact, many 2b trucks are simply larger versions of a manufacturer's 2a model with engines and transmissions that can be nearly identical in configuration. Like light-duty trucks, more than 90 percent of 2b and 3 vehicles are sold as 'complete' vehicles, as defined by EPA.[80] EPA also confirms that the "technologies that can be used to reduce fuel consumption and GHG emissions from this segment are very similar to the ones used for lighter pickup trucks and vans (Class 2a)."[81] These technologies include, but are not limited to, engine improvements such as friction reduction, cylinder deactivation, cam phasing, and gasoline direct injection; aerodynamic improvements; low rolling resistance tires; and transmission improvements. In addition to the same efficiency technologies, Class 2a and 2b trucks are both certified with chassis dynamometer testing.[82]

The use of class 2b and 3 vehicles can vary widely but many of the uses are the same as light-duty trucks: they can be strictly personal-use vehicles, vehicles that double for both work and personal use, or vehicles that are used solely for commercial purposes (cargo vans). Many are purchased to perform a certain work function and need a specific workload and towing capacity. However, despite varying workloads and towing capacities of 2b trucks, their similarities outweigh their differences.

Based on these similarities, EPA and NHTSA should develop window labels for 2b and 3 vehicles that provide comparable information afforded to consumers of light-duty cars and trucks. Given that these vehicles are often purchased to perform a certain work function, it

may also be appropriate to provide payload and towing capacity on the label to allow for easy cross-vehicle comparisons in combination with fuel efficiency information.

Recommendations

1. Labels for 2b and 3 vehicles should be finalized in conjunction with Phase 2 fuel economy standards

   The Energy Policy and Conservation Act (EPCA) of 1975 mandated that all auto manufacturers label all new automobiles pursuant to EPA requirements. The Energy Independence and Security Act (EISA) of 2007, required EPA, DOT and DOE to establish several new labeling requirements including greenhouse gas emissions and a rating system that would allow consumers to make comparisons to an average vehicle. The updated light-duty labeling rule was finalized with updated fuel economy and greenhouse gas standards for light-duty vehicles. That provided EPA and DOT the opportunity to develop labels that would reflect the increased fuel economy and cost savings from advanced technologies like plug-in hybrids and electric vehicles. It also allowed manufacturers to harmonize the development and roll out of new vehicles and new labels at the same time.

   EPA should similarly develop window labels for 2b and 3 vehicles with the development of the Phase 2 fuel economy and GHG rule and the Tier 3 rule. This would provide manufacturers of 2b and 3 vehicles with integrated planning, similar to the issuance of light-duty labels and emissions standards, and provide important transparency for consumers.

2. EPA should consider carrying out an expert assessment to inform 2b/3 label design and rely on pertinent findings from the development of light-duty labels

   EISA 2007 required DOT and EPA to update light-duty label designs and include GHG information. It also required the Agencies conduct consumer education outreach. The label redesign process included the following:

   - Literature review –examining vehicle buying process, information sources used by consumers as they shop for vehicles, the factors that influence consumer vehicle purchasing decisions, and the impact of the increasing availability of more efficient and lower emitting vehicles.
   - Focus groups (in 3 phases) – 4 cities over 4 months, 32 focus groups including 257 people.
   - Expert panel – included executives from Zappos, Unilever, Pandora, Craigslist, and Gates Foundation. It was an intensive one-day workshop to elicit ideas.
   - National level online survey of new vehicle buyers – an Internet survey designed to elicit responses about new label ideas.

The innovative ideas and information collected from the redesign process resulted in consumer-friendly window labels that reduce the market barrier to purchasing cleaner, more efficient light-duty vehicles. We recommend EPA consider the pertinent findings and engage in consumer and expert outreach to inform label design for 2b and 3 vehicles.

3. Agencies should develop an online tool for all medium and heavy-duty vehicles

In addition to the label redesign, the agencies launched an online education campaign for light-duty vehicles. Window labels direct buyers to the EPA website www.fueleconomy.gov to see the full Fuel Economy Guide. The website also allows a user to personalize their fuel economy information by inputting their specific driving habits and fuel prices and tells the buyer the cost to fill the tank, or the volume of the fuel tank, or how many miles could be driven on a tank. The information such as the miles per tank can be personalized to reflect a person's relative amount of city and highway driving. This information is helpful to a potential consumer, as more consumers are starting their buying research online.

Similar information could be provided to consumers of all types of medium- and heavy-duty vehicles. In addition to the labels, the Agencies could provide the same personalized online information for 2b and 3 consumers as the light-duty online tool.

For vehicle classes 4-8, EDF encourages the EPA to use the data and information collected during the development of the Phase 2 rule to develop a user-friendly online calculator or tool that would allow consumers to conduct personalized research of various vehicle configurations. The tool would produce average fuel economy over select duty cycles. This tool would provide rigorous, reliable information on vehicle efficiency and emissions performance to inform consumer choices.

CONCLUSION

EPA and NHTSA have a responsibility to reduce the climate pollution and improve the fuel efficiency of newly manufactured heavy-duty vehicles. These trucks and buses have long operational lives and strong, well-designed standards can likewise deliver long-lasting societal benefits. A protective Phase 2 program for medium- and heavy-duty vehicles could put the sector on a path to absolute emissions reductions in the next decade, complementing a similar path already finalized for the passenger vehicle sector.

A rigorous Phase 2 program would result in meaningful benefits across our society. Such a program would mitigate the greenhouse gas emissions that contribute to public health and environmental harms. The significant reduction in oil consumption would strengthen our

energy security. A robust program will drive innovative technologies that will stimulate economic growth and create high-quality domestic jobs. It would also result in broad economic benefits to all users of the freight system – from the individual truck owners who pay at the pump, to the large clients who pay fleets to ship their merchandise by truck. The Agencies should account for the full range of benefits that will accrue from a bold and innovative program. The economic, health, and environmental benefits to our society are far reaching.

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[74] MDPV criteria outlined in 40 C.F.R. §86.1803-01 "*Medium-duty passenger vehicle (MDPV)* means any heavy-duty vehicle (as defined in this subpart) with a gross vehicle weight rating (GVWR) of less than 10,000 pounds that is designed primarily for the transportation of persons. The MDPV definition does not include any vehicle which:
(1) Is an "incomplete truck" as defined in this subpart; or
(2) Has a seating capacity of more than 12 persons; or
(3) Is designed for more than 9 persons in seating rearward of the driver's seat; or
(4) Is equipped with an open cargo area (for example, a pick-up truck box or bed) of 72.0 inches in interior length or more. A covered box not readily accessible from the passenger compartment will be considered an open cargo area for purposes of this definition."
[75] These definitions of vehicle classes that divide 2a and 2b trucks into different regulatory categories are consistent across all EPA and NHTSA rulemakings relating to light-duty and medium/heavy-duty vehicles, including tailpipe and fuel standards, fuel economy and greenhouse gas standards, and labeling requirements.
[76] EPA and NHTSA, Final Rulemaking to Establish Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, Regulatory Impact Analysis," (2011), Page 1-6. (Final RIA).
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