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REGULATORY CONSIDERATIONS FOR ADVANCING COMMERCIAL PICKUP AND VAN EFFICIENCY TECHNOLOGY IN THE UNITED STATES

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EXECUTIVE SUMMARY

The United States is primed to propose a second phase of long-term carbon emissions and efficiency standards for its medium- and heavy-duty vehicles with gross vehicle weight rating (GVWR) above 8,500 lb. The lightest part of the heavy-duty fleet, the commercial pickups and vans (i.e., 8,500 to 14,000 lb GVWR), represent more than half of overall medium- and heavy-duty vehicle sales. Many of these light commercial pickups and vans share engines, vehicle designs, and functional attributes with similar large light-duty trucks that are seeing increased efficiency options in the market due to long-term light-duty efficiency regulations. As the United States deliberates on its next phase of heavy-duty vehicle standards, the timing is ripe for a deeper investigation into several technical and policy aspects of these commercial pickups and vans.

This report analyzes new commercial pickup and van sales and efficiency technology data to inform the next phase of commercial pickups and vans for model year 2020 and beyond. This analysis of recently available data provides several findings that relate to the establishment of a second phase of standards for light commercial pickups and vans. Data published since the original 2014-2018 efficiency rulemaking that are analyzed here include regulatory vehicle data, updated sales, technology developments, and state-of-the-art vehicle simulation data on full-size pickups and vans.

The findings of this report inform on baseline technology characteristics and the rate of technology improvement in large light-duty and commercial pickups and vans. The data reveal that commercial pickup trucks and vans share many similarities with their lighter counterparts, including their vehicle size, work attributes, and technology availability. As illustrated in Figure ES-1, the findings indicate that the light-duty efficiency standards are pushing efficiency technology at a much greater rate, potentially setting the stage for equivalent progress in the heavier segment. The figure shows baseline CO_2 emissions from all 2010 large body-on-frame pickups and vans versus work factor and their relative average CO_2 reduction requirements from adopted rulemakings. The data for light-duty pickups and vans is from a lighter test weight protocol; therefore, those data would move up on the vertical axis, but remain at the same work factor, if they were tested as heavy-duty vehicles. The "work factor" is the formal regulatory index (based on payload, four-wheel drive, and towing capability) upon which the existing commercial pickup and van standards are based. To achieve the adopted standards, heavy-duty commercial pickups and vans are required to reduce their exhaust CO_2 emissions by less than 10% by 2018, whereas the large light-duty pickup and van counterparts face a 40% exhaust CO_2 reduction by 2025.

Figure ES-1. Baseline light- and heavy-duty pickups and vans and their differing adopted regulatory stringency

In addition, the findings indicate that neither international precedent nor US market considerations support the need for separate gasoline and diesel standards. The prevailing regulatory design artificially protects gasoline commercial pickups and vans from regulatory CO_2 competition against diesels that, on average, have 4% lower CO_2 emissions and 22% higher work factor capacity. Figure ES-2 shows this disparity in the baseline spread and sales-weighted averages of the gasoline and diesel models' CO_2 emissions, and the gasoline models' less stringent standards. This analysis indicates that heavy-duty gasoline engines have more ongoing developments and technology potential to improve efficiency than diesel engines, eliminating the need to continue separate fuel-based standards.

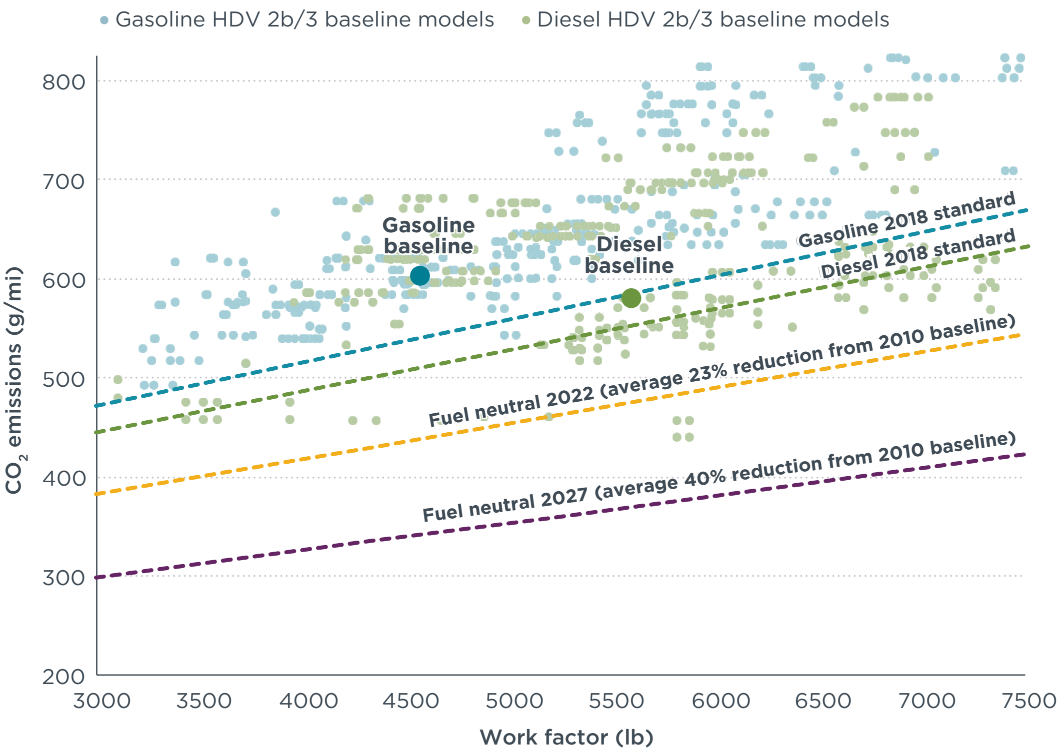

Figure ES-2. Baseline commercial pickups and vans and separate model year 2018 CO2 standards for gasoline and diesel vehicles

Based on the analytical findings, the study tests the assumptions that shaped the first phase of standards and points to three main recommendations for the second phase of standards.

Establish commercial pickup and van CO_2 emission and efficiency standards that are as technology-forcing as the light-duty vehicle standards. Setting the post-2020 commercial pickup and van standards to be as technology-forcing as the light-duty standards for large pickups and vans would include 4-5% per year reductions in CO_2 emissions through 2025-2030, applying technologies similar to those being deployed in full-size light-duty pickups and vans.

Make commercial pickup and van CO_2 emission and efficiency standards fuel neutral for 2020 and beyond. Developing "fuel neutral" commercial pickup and van performance standards that require the same level of emissions for a given level of functionality, without regard for fuel type, would (a) most equitably and cost-effectively promote low-carbon technology; (b) be in accord with the general international principles on technology-neutral performance standards; (c) be consistent with the US light-duty standards for pickup trucks and vans; (d) help ensure gasoline-focused companies are developing competitive and efficient vehicles in this class; and (e) better protect against upward shifts in trucks' average work factor over time that will otherwise erode regulatory program benefits.

Figure ES-2 illustrates hypothetical post-2020 fuel neutral standards that would remove the artificial protection of gasoline engines from the existing US commercial pickup and van standards. Such an approach would establish a technology-forcing program that addresses market dynamics and allows companies to cement their technology leadership in this US market segment.

Require public availability of commercial pickup and van sales, CO_2 emissions, fuel consumption, and vehicle attribute data. Commercial pickup and van sales are apparently somewhere between 600,000 and 1.2 million vehicles per year, depending on the data source. This data uncertainty raises a number of questions. Any systematic trend of pickups and vans upward from the light-duty category to the less stringent heavy-duty category would present a significant erosion of regulatory benefits and would suggest that a leveling of the light- and heavy-duty regulatory stringency is in order. Recent data suggest that sales of heavy-duty pickups and vans are increasing far more rapidly than projected, suggesting that such an upward trend is already occurring. Better public disclosure on market shifts related to this vehicle class is important to assess the effectiveness of the existing rule and to better evaluate what is at stake in the 2020-and-beyond rulemaking.

The implications of this study go beyond particular questions about the optimal US regulatory design for promoting efficiency technology for greater fuel savings among gasoline and diesel trucks. At stake is the larger principle of whether governments around the world are in the business of setting separate environmental standards that are skewed toward preferred vehicle technology types. This is important for gasoline and diesel vehicles, but it is also important for alternative fuels that might eventually be able to unseat the incumbent petroleum fuels. For example, natural gas and electric-drive technologies only get to compete and contribute toward regulatory goals if they are integrated within the same fuel-neutral standards as conventional vehicles. The strongest and most cost-effective long-term policies promote all technologies according to their energy and emissions characteristics, and then let the market do the rest.

I. INTRODUCTION

Heavy-duty vehicles in the United States are, along with power plants and passenger vehicles, one of the most significant sources of carbon dioxide (CO_2) emissions. Globally, heavy-duty vehicles are the dominant transportation energy use and CO_2 emissions contributor in major emerging economies (e.g., China, India, Brazil). Globally, heavy-duty trucks were responsible for using approximately 12 million barrels of oil per day and producing 2.5 billion tons of CO_2 per year in 2013 (Façanha et al, 2012). In 2013, the US heavy-duty vehicle fleet consumed almost 3 million barrels worth of oil per day (US EIA, 2013). All of this, and the relative lack of market and regulatory pressure to date to increase efficiency globally, makes heavy-duty vehicles a prime target for regulatory policy to reduce their energy and climate impacts.

The United States, in late 2014, is at an especially important moment for establishing a long-term heavy-duty vehicle efficiency policy. The White House announced in early 2015 a timetable for proposing a second phase of heavy-duty vehicle efficiency standards for 2020 and later trucks, with expected finalization in 2016 (White House, 2014). This presents an opportunity to develop technology-forcing standards that exert comparable climate, energy, and technology leadership for trucks, as the government promulgated for automobiles just several years ago with its 2025 efficiency standards.

The prevailing first phase of US truck efficiency standards pertains to medium- and heavy-duty vehicles with gross vehicle weight rating (GVWR) above 8,500 lb, of model years 2014 through 2019 (see US EPA and NHTSA, 2011b). Along with standards' requirements for engines, vocational trucks, and heavy-duty tractors, the first phase of standards has particular requirements for manufacturers of commercial pickups and vans. Under the first phase of standards, commercial pickups and vans from 8,500 lb to 14,000 lb GVWR are required to reduce their average CO_2 emissions and fuel consumption by set amounts according to the vehicle models' work capabilities. The pickup and van standards are based on the same city and highway test cycles used in the light-duty vehicle regulations, but they include increased loaded test weight and differing stringency for gasoline and diesel fueled trucks.

The importance of this policy-making moment is greater when viewed from a global perspective. Globally, a relatively small number of companies sell most of the world's trucks, but they still sell considerably lower volumes of trucks than light-duty automobiles. The timing of this US heavy-duty vehicle rulemaking is important internationally. The governments of China, Japan, and Canada are contemplating their next phase of heavy-duty vehicle efficiency standards. In addition, the governments of the European Union, Mexico, and India are considering heavy-duty vehicle efficiency policy. Based on 2013 data, the United States produces 36% of the global market's light commercial vehicles, compared to 7% of passenger automobiles and heavy trucks (OICA, 2014a). This makes the 2015-2016 US rulemaking for 2020 and later heavy-duty vehicles a key opportunity for the United States to demonstrate leadership on the regulatory framework and standards that promote leading efficiency and low-carbon technology for light commercial vehicles.

One of the more prominent open questions for the second phase of US heavy-duty vehicle standards is how optimally to develop standards for the lightest of the heavy-duty vehicle classes. The lightest heavy-duty vehicles — commercial vans and pickups between 8,500 and 14,000 lb GVWR — represent the largest segment by sales for US heavy-duty vehicles. These commercial vans and pickups are, typically, the heavy-duty versions of the higher-volume light-duty counterparts. For example, the Chevrolet Silverado 1500, Dodge Ram 1500, and Ford F150 are within the light-duty vehicle weight thresholds, whereas the GM 2500/3500, Dodge 2500/3500, and Ford F250/F350, are Class 2b (8,501-10,000 lb GVWR) and Class 3 (10,001-14,000 lb GVWR) heavy-duty vehicles. In addition, there are many relatively new US market entrants, including the Ford Transit, the Mercedes Sprinter, the Ram ProMaster, and the Nissan NV. Many of these newer models borrow from European commercial van body styles, have high cargo capacity, and use smaller V-6 and I-4 engines (e.g., see Hetzner, 2014; Cain, 2014a, 2014b). Among the important competitive, marketed specifications of these trucks is their ability to haul payload, tow trailers, and perform varied work functions.

This segment has a number of elements that make it ripe for a much deeper investigation of the technology and regulatory design elements. First, the initial phase of standards for model years 2014-2018 offers a framework for standards, but the relative lack of data prevented the typically more thorough investigation. Now, in 2014, there are far more, and far richer, data to assess the fleet, the technology potential, and the regulatory provisions. In particular developments in gasoline and diesel engine technologies indicate that this segment that straddles the light- and heavy-duty spaces has the potential for substantial efficiency improvements. Because there are multiple fuel types (gasoline, diesel, and increasingly natural gas) in this segment, how precisely the different fuel types are accounted for is not a trivial matter.

This report offers an assessment of commercial pickups and vans based on recent sales, CO_2 emissions, and efficiency technology data. In particular this report's primary objectives are to inform some of the key questions that were largely unresolved or incompletely analyzed in the first phase of standards — in particular about regulatory design and technology availability. For example, is a regulatory design that indexes stringency to fuel type (i.e., gasoline and diesel) and work capability optimal? Related to this are questions about what international precedents there are for setting fuel-specific standards, and what risks might exist in upward trends in trucks' work capability undermining overall policy goals. Another question is what the extensive analysis of large light-duty pickups and vans for the 2017-2025 light-duty vehicle efficiency rulemaking might mean for heavy-duty pickup and van standards for 2020 and beyond. Related to this, what technology developments in the light-duty truck sector are likely to be available to increase the efficiency of heavy-duty commercial pickups and vans?

To attempt to answer these questions, the report has three main analytical parts: An investigation of recent data on trends and breakdown of vehicles in this segment (Section II), analysis of the existing regulatory design of separate gasoline and diesel standards (Section III), and an assessment of technologies for increased efficiency (Section IV). A discussion section (Section V) goes beyond the analysis to discuss a potential shift toward fuel neutral standards and efficiency technology trends. The final section (Section VI) offers several final conclusions and recommendations for the next phase of efficiency standards for 2020 and later commercial pickups and vans.

II. DATA ON COMMERCIAL PICKUPS AND VANS

This section explores available data on vehicle sales and characteristics of commercial heavy-duty pickups and vans. In particular, the section analyzes data from the US Environmental Protection Agency (EPA), the National Highway Traffic Safety Administration (NHTSA), Polk, Wards, *Automotive News*, and the US Bureau of Economic Analysis (BEA) to quantify sales by vehicle, fuel type, company, and regulatory weight class in the 2010-2013 time frame.

SALES OF COMMERCIAL PICKUPS AND VANS

The categorization of heavy-duty pickups and vans is not entirely consistent across data sources. Commercial pickups and vans, as regulated under the 2014-2018 EPA and NHTSA heavy-duty vehicle regulations, constitute most of the Class 2b and Class 3 vehicles from 8,501 to 14,000 lb GVWR. These heavy-duty standards do not apply to the Class 2b Medium Duty Passenger Vehicles (i.e., generally sport utility vehicles and passenger vans between 8,501 and 10,000 lb GVWR that can fit less than 12 persons), which are subject to the light-duty vehicle regulatory standards. Above and henceforth, we refer to the segment of “commercial pickups and vans” as those that are below 14,001 lb GVWR and are subject to the heavy-duty vehicle regulations. Approximately 90% of heavy-duty pickups and vans are 3⁄4-ton and 1-ton pickup trucks, 12- and 15-passenger vans, and large work vans that are sold by vehicle manufacturers as complete vehicles (US EPA and NHTSA, 2011).

We compiled data from multiple sources to attempt to quantify the number of new commercial pickups and vans that are subject to the heavy-duty vehicle regulation. Sources generally rely on state new vehicle registrations in their collection of new vehicle data, and they use their own methods to clean and process the data. Figure 1 shows a summary of vehicle registration data for all vehicles that are at or below 14,001 lb GVWR. Three sources in the figure (i.e., Wards, 2012; Automotive News, 2014; BEA, 2014) report on the total registrations of all vehicles up to 14,001 lb GVWR, and these sources are nearly identical (i.e., within 0.5% of each other). We also show the official model year estimates for production of light-duty vehicles, including all those up to 8,500 lb GVWR, according to the EPA (US EPA, 2013). As the data show, the gap between the vehicles under 14,001 lb and the vehicles regulated in the light-duty vehicle regulation is increasing. The number was about 450,000 in 2010, and it has increased to 1.0 million in 2012 and 1.2 million vehicles per year in 2013.

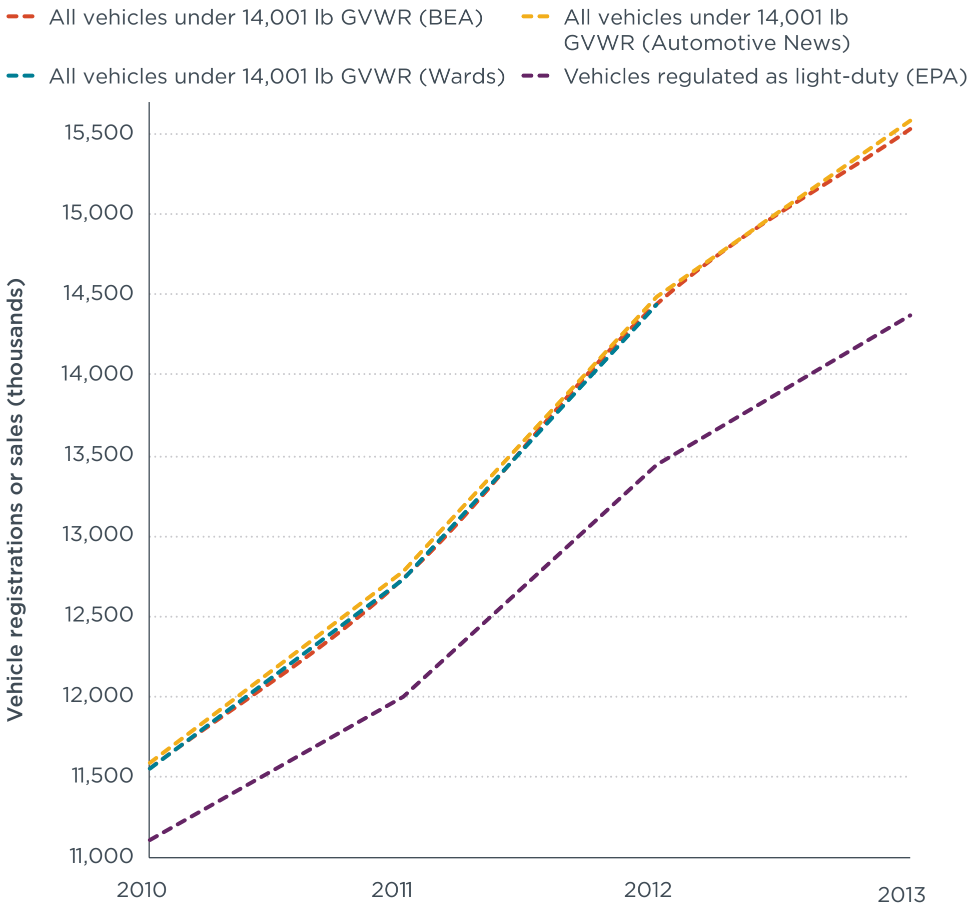

Figure 1. Total new vehicles Class 1-3 vehicles (i.e., under 14,001 GVWR), and total vehicles that fall under light-duty vehicle regulation

As the data in Figure 1 indicate, there is a significant amount of vehicle sales at or below 14,000 lb GVWR in the Class 2b and 3 categories that are falling outside the light-duty vehicle regulation. We note that the data shown are collected under different methods and with different contexts. The industry data sources are based on total sales, measured as new vehicle registrations, by calendar year. The EPA data are measured on a model year basis. Model year sales are mostly within the same calendar year, but can spill over into three calendars years (i.e., including one or two quarters before the model year, and one or two quarters after the model year, depending on when production lines turn over, and inventories are cleared). However, based on the gap in Figure 1 steadily increasing over four years, it is clear that this trend and the large gap cannot be explained away as calendar-versus-model year accounting. For comparison, the agencies estimated that the commercial pickup and van sales were about 580,000 per year in 2010 and were projected to increase to be between 700,000 and 800,000 per year for 2014-2021 (US EPA, 2011). As a result, the recent sales data would appear to indicate there now are far more commercial pickups and vans than in 2010, and that the sales are increasing at a significantly greater rate than the agencies had projected.

To better understand the more detailed attributes, we also analyzed Polk data on new calendar year 2012 registrations in the United States for this vehicle segment. Figure

2 illustrates new Class 2b and 3 vehicle volumes in the context of overall heavy-duty vehicle registrations (based on Polk, 2013). The data show the total new Class 2b and 3 registrations to be approximately 500,000 vehicles — only about half of the one million vehicles estimated by subtracting EPA's light-duty sales from overall sales of vehicles up to 14,000 GVWR. Overall, the Polk data show an increase from fewer than 300,000 new vehicles in 2009 to about 500,000 in 2012.

As shown, Class 2b and 3 vehicles make up a substantial portion of all new heavy-duty vehicles: Class 2b trucks represent 38%, Class 3 trucks make up 19%, and together Class 2b and 3 trucks make up 57% of all new 2012 heavy-duty vehicles. Overall, new heavy-duty vehicles are 69% diesel-fueled. Diesel is dominant in Class 7-8 vehicles, but the gasoline-diesel split is more even for the lighter vehicle classes. In 2012, about 50% of Class 2b vehicles, 71% of Class 3, and 57% of Class 2b and 3 together are diesel-fueled. These data are notably inconsistent with the above data that suggest that Class 2b and 3 vehicles in 2012-2013 could be approximately 1.0-1.2 million vehicles.

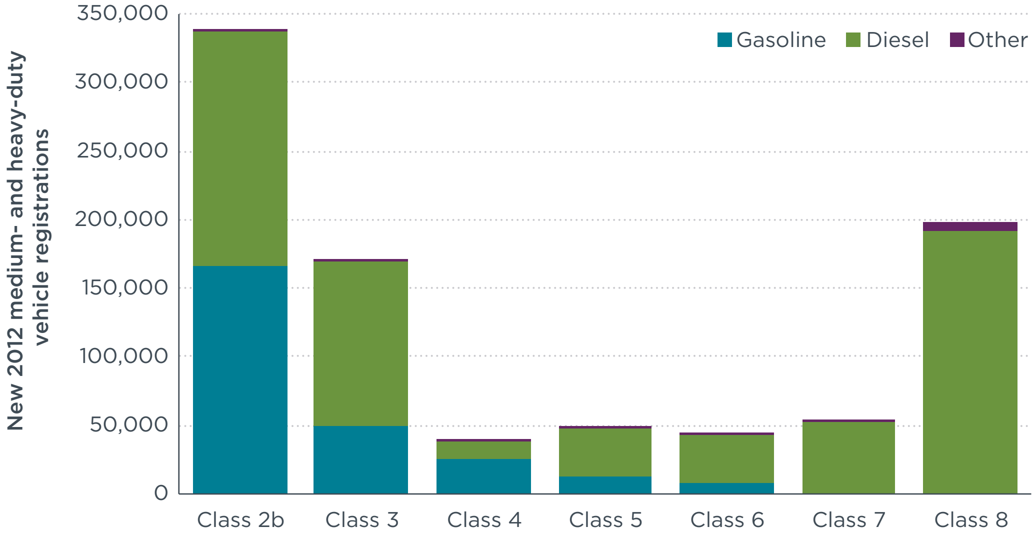

Figure 2. New 2012 heavy-duty vehicle registrations by class and fuel type (Polk, 2013)

As depicted in Figure 3, new vehicle registrations of Class 2b and 3 vehicles are dominated by three companies: Ford, General Motors, and Chrysler. Based on these Polk data, Ford makes up about 51% of the 2b and 3 vehicles, GM has 32%, and Chrysler has 15%, Mercedes has 1%, and the rest account for 1%. There are several high volume engines from these three companies that made up the vast majority of the segment's new 2012 registrations. Seven engine sizes — Ford's 4.6L, 5.4L, 6.2L, and 6.7L; GM's 6L and 6.6L; and Chrysler's 6.7L — made up 97% of the Class 2b sales and 91% of Class 3 sales.

Figure 3. New 2012 registrations of Class 2b and 3 vehicles by company (Polk, 2013)

As a final note on the overall sales data comparisons here, there is an evident lack of comprehensive data on Class 2a (light-duty) and Class 2b and 3 (heavy-duty) commercial pickups and vans to further analyze the associated trends. The numbers above from Wards and *Automotive News* suggest there could have been over a million vehicles per year in the heavy-duty commercial van and pickup segment in 2012-2013. The EPA model year 2010 data suggest about 790,000 sales. The Polk data indicate only about 400,000 to 500,000 new annual registrations of Class 2b and 3 from 2010 through 2012. These discrepancies likely represent a substantial shift upward from the light-duty to the heavy-duty vehicle segments in vehicle categorization and vehicle sales.

DIFFERENCES BETWEEN LIGHT-DUTY AND HEAVY-DUTY PICKUPS AND VANS

For greater context in understanding the commercial pickup and van baseline fleet, Table 1 summarizes basic sales-weighted average differences in attributes between the full-size vans and pickups within three vehicle categories. The data are from model year 2010, as used in the light-duty and heavy-duty vehicle rulemakings (i.e., US EPA, 2010; US EPA and NHTSA, 2012).

The first vehicle class in the table shows full-size cargo vans and pickups based on body-on-frame construction and regulated as “light-duty vehicles” from a regulatory CO_2 and efficiency perspective. These light-duty vehicles include all commercial vans and pickups with a GVWR at or below 8,500 lb, and also a small number of larger vans classified as medium-duty passenger vehicles between 8,501 and 10,000 lb, as mentioned above.

The next two categories in the table are for the heavy-duty Class 2b (GVWR 8,501-10,000 lb) and heavy-duty Class 3 vehicles (GVWR 10,001-14,000 lb). Manufacturers specify the GVWR according to the maximum amount of loaded vehicle weight, including passengers, fuel, and payload. As shown here, the average vehicle weight (i.e., curb or empty) varies much less than the average GVWR for the three classes.

Table 1. Comparison of average model year 2010 light- and heavy-duty pickups and vans

Vehicle class [a]	Approximate 2010 volume (thousands)	CO_2 rate[b] (g/mi)	Fuel economy[b] (mpg)	Vehicle weight (lb)	Gross vehicle weight rating (lb)	Engine size (L)	Vehicle footprint[c] (ft^2)	Percent diesel
Large light-duty pickups and vans	1,006	462	19.2	5,235	6,736	5.2	67.4	0%
Heavy-duty Class 2b pickups and vans	590	573	16.4	6,388	9,266	5.9	70.3	44%
Heavy-duty Class 3 pickups and vans	200	642	15.1	6,966	11,757	6.2	78.2	69%

Sources: US EPA, 2010; US EPA and NHTSA, 2012

a Large light-duty full-size pickups and vans are mostly Class 2a (i.e., less than 8,500 lb GVWR) but this category also includes a small number of Class 2b "medium duty passenger vehicles" that are classified as light duty for emission regulations

b Fuel economy and CO2 emissions from combined 55% city / 45% highway procedure; Class 2b and 3 values based on average loaded vehicle weight (i.e., average of curb and gross vehicle weight), light-duty test weight is binned curb weight plus 300 lb.

c Vehicle footprint is defined as the wheelbase times the average track width

The light- and heavy-duty pickup and van models have a number of differing attributes that correspond with their increasing GVWR and functional market characteristics. As summarized in Table 1, the heavy-duty versions tend to be heavier, and they tend to have higher weight capacity, larger engine displacement, and larger vehicle footprints. Another difference is that the light-duty trucks are predominantly gasoline powered, whereas the heavy-duty Class 2b and 3 pickups and vans have much higher diesel fractions.

Based on these 2010 data, there are about one million full-size light-duty van and pickup sales per year, compared to about 790,000 heavy-duty commercial pickups and vans. As shown, the CO_2 emission rates on the combined EPA city-highway test cycle increase with vehicle class. It is also noted that the makeup of vehicle types differs somewhat within the three full-size truck classes in Table 1. For example, vans (cargo and passenger) represent 2% of the light-duty, 26% of the Class 2b, and 8% of the Class 3 pickups and vans. The heavy-duty Class 2b vehicles have approximately 35% higher, and Class 3 vehicles 40% higher, CO_2 emissions than their light-duty counterparts (though the test procedure weight load requirements differ, as described further below). Previous analysis highlighted more detailed differences, including model-to-model comparisons of vehicle attributes and efficiency (Khan and Langer, 2012).

Analyzing the sales breakdown for light-duty and heavy-duty pickups and vans according to several different attributes provides further comparison. Figure 4 shows the distribution of 2010 vehicles sales of pickups and vans in the three vehicle categories of full-size light-duty trucks and heavy-duty commercial pickups and vans of Classes 2b and 3, by four major vehicle classification variables (again based on data from US EPA, 2010; US EPA and NHTSA, 2012).

The first row shows GVWR, which is the dominant factor that separates light-duty, Class 2b heavy-duty, and Class 3 heavy-duty vehicles. Note that there are only about 100,000 full-size light-duty vehicles sold per year that are above 7,000 lb GVWR — and almost none between 7,500 and 8,500 GVWR.

The second part of the figure shows the vehicle curb weight distribution for the vehicles. As shown, there is substantial overlap in the light-duty and heavy-duty Class 2b vehicle sales between 5,000 and 6,000 lb curb weight. This indicates that similar pickups and vans of the same curb weight can be categorized as light-duty or heavy-duty pickups or vans.

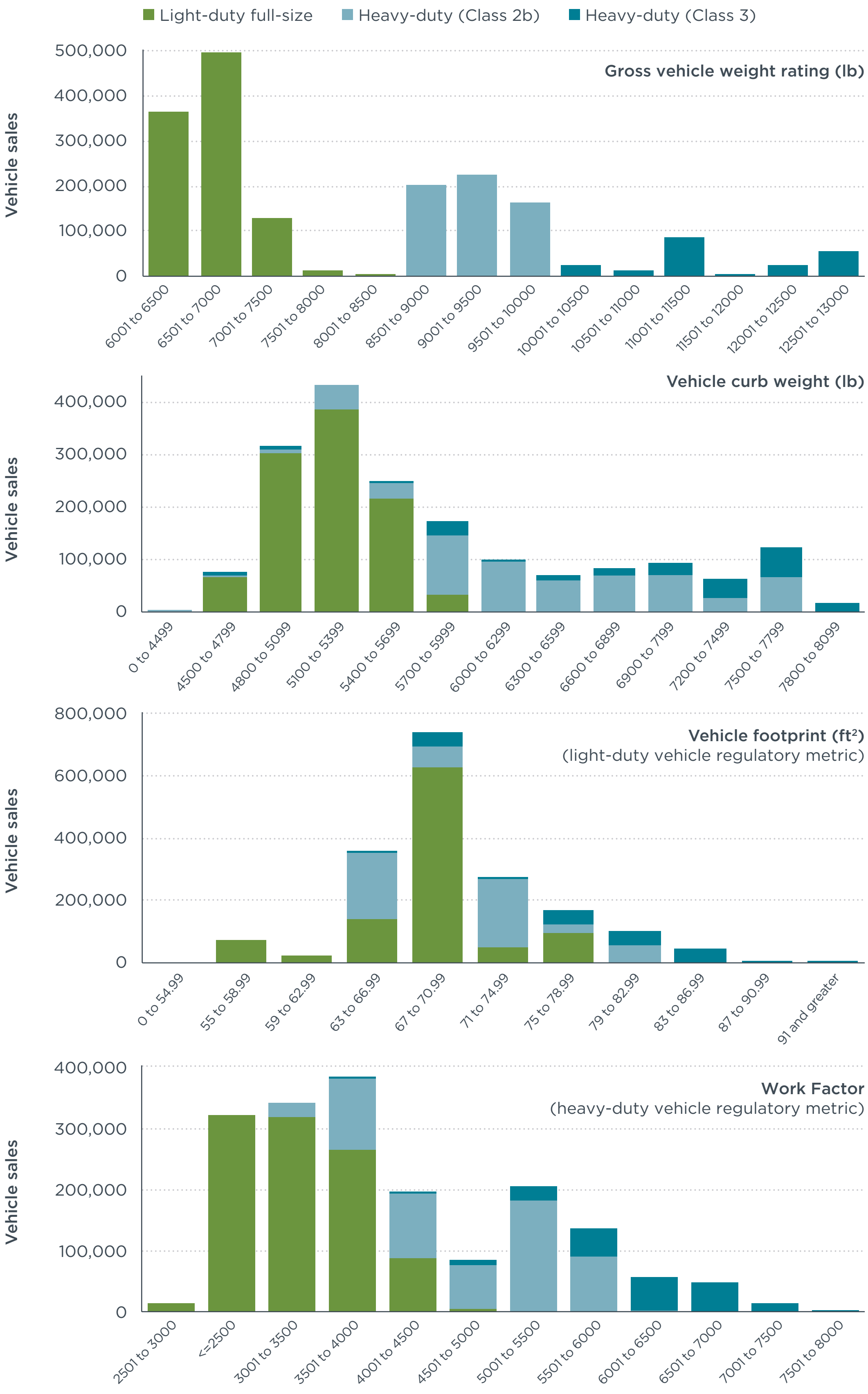

Figure 4. Distribution of model year 2010 light- and heavy-duty pickups and vans

Also in Figure 4 are the distributions of the 2010 vehicle sales according to the two attributes used for the light-duty and heavy-duty vehicle regulatory standards. Light-duty vehicles are subject to CO_2 and efficiency regulatory targets that are proportional to the vehicle footprint (i.e., wheelbase times average track width). As shown in the table, there is substantial overlap in the vehicle sizes, whereby the footprint of most of the light-duty and 2b pickups and vans are between 63 and 75 square feet.

Heavy-duty commercial pickups and vans are subject to greenhouse gas (GHG) and efficiency regulatory targets that are proportional to the vehicles' "work factor," which is described further below. In particular the light-duty and heavy-duty Class 2b pickups and vans have greatly overlapping work factor utility characteristics — with sales of both light-duty and heavy-duty vehicle classifications being greater than 100,000 units per year between 3501 and 4500 lb work factor. Based on these comparisons, we see that similar light- and heavy-duty vehicles are fundamentally separated by their regulatory categories (i.e., GVWR), although their functionality, as described by their footprint and work factor, has considerable overlap for significant portions of their sales.

III. REGULATORY DESIGN

The regulatory design of the commercial pickup and van standards involves the indexing of regulatory stringency to various truck capabilities and whether the trucks are gasoline- or diesel-fueled. The regulatory stringency is built around a “work factor” that indexes the CO_2 and fuel consumption standards to a metric that incorporates the payload, towing, and four-wheel-drive capabilities of these trucks. Vehicle models with higher payload and towing capacity, and with four-wheel drive, are granted higher fuel consumption and CO_2 targets for the model year 2014-2018 standards. Company-specific regulatory CO_2 standards then are based on the sales of all vehicles of each model year and separate linear relationships between work factor and CO_2 emissions for gasoline and diesel vehicles.

Figure 5 shows how the baseline heavy-duty pickup and van fleets used in the rulemaking compare to the model year 2018 standards. The data are based on EPA data in the public rulemaking docket (US EPA, 2010). The data show the large spread and overlap of the CO_2 emissions of the gasoline and diesel models. On a sales-weighted average basis, diesel pickups and vans offer 22% greater work factor at 4% lower CO_2 emissions per mile than gasoline vehicles.

The figure also shows the work factor-based CO_2 standards that are indexed to payload capacity, the towing capacity, and whether the vehicle has four-wheel-drive capability. Assuming the same fleet mix by work factor, the regulatory standards for model year 2018 would put the gasoline pickup and van fleet on average 10% lower. Similarly assuming the same mix of diesel vehicles by work factor, diesel vehicles would, on average, have to shift downward by 5% from the 2010 baseline to achieve 2018 compliance. Comparing the 2018 gasoline and diesel CO_2 standard lines throughout the work factor range of 3,000 to 8,000, the diesel standards are 5.5%-5.6% lower than the gasoline standards.

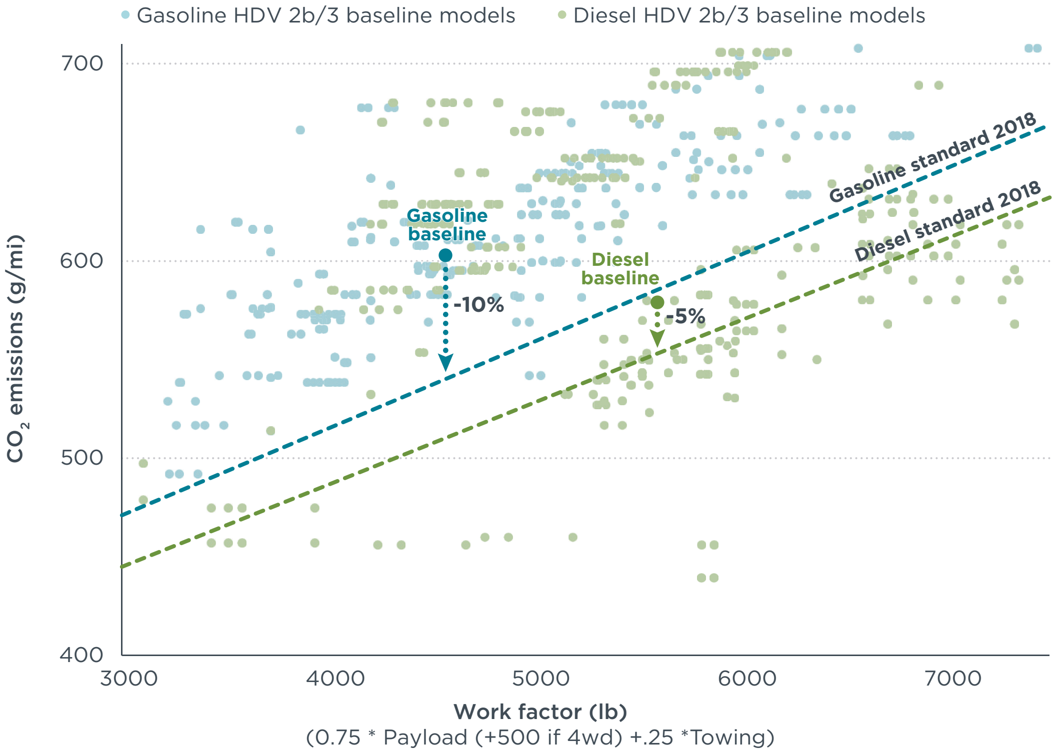

Figure 5. Baseline commercial pickups and vans and 2018 CO_2 standards for gasoline and diesel vehicles (based on US EPA, 2010)

PHASE I DEBATE OVER PICKUP AND VAN REGULATORY DESIGN

There was some disagreement among the stakeholder comments toward the determination of the separate gasoline and diesel standards in the 2014-2018 rulemaking. Cummins and the Engine Manufacturers Association objected to the separate diesel and gasoline standards, suggesting fuel neutrality and equitable regulatory burden should be maintained. The three major heavy-duty pickup and van manufacturers (i.e., Chrysler, Ford, GM) did not explicitly support or object to separate gasoline and diesel standards according to their publicly available comments. Many civil society groups indicated that the National Academy of Sciences (NAS) study (i.e., NRC, 2010) showed greater technology availability from both gasoline and diesel technologies than the agencies' regulatory stringency determination and that many light-duty pickup and van technologies can be applied in the heavy-duty pickups and vans.

The agencies noted that the use of separate fuel-based standards by work factor was appropriate to account for prevailing technology differences across the heavy-duty pickup and van fleet. EPA and NHTSA closed the discussion on the topic with the following note:

> "The agencies agree that standards that do not distinguish between fuel types are generally preferable where technological or market-based reasons do not strongly argue otherwise. These technological differences exist presently between gasoline and diesel engines for GHGs, as described above. The agencies emphasize, however, that they are not committed to perpetuating separate GHG standards for gasoline and diesel heavy-duty vehicles and engines, and expect to reexamine the need for separate gasoline/diesel standards in the next rulemaking."
>
> (US EPA and NHTSA, 2011a)

So a clear question springs from first phase of the commercial pickup and van standards: Should differing regulatory stringency for gasoline and diesel vehicles be maintained for model year 2020 and beyond standards?

INTERNATIONAL PRACTICES ON FUEL NEUTRAL STANDARDS

This issue of how to treat the two dominant petroleum-based transportation fuels has come up many times in regulatory deliberations around the world. Table 2 summarizes various rulemakings that considered differentiating the stringency of gasoline and diesel vehicle regulations for efficiency, CO_2, and other emissions. As shown, governments have generally, but not always, opted to adopt the same regulatory stringency for gasoline and diesel vehicles.

As summarized in Table 2, most vehicle and engine regulations around the world maintain the same regulatory stringency for gasoline and diesel vehicles. The United States, China, and the EU together represent about 60% of world vehicle sales (OICA, 2014b), and most countries tend to follow the EU system of emissions regulations. As these regulations were deliberated, stakeholders tended to focus on the importance of the level of regulatory burden and emission-reduction stringency, and less so on partitioning the standards for differential stringency by fuel type. Generally, the principle of setting equal performance-based standards is cited.

Governments tend to put a greater importance on the environmental performance (i.e., the grams pollutant per mile, the fuel consumed per mile) than the market conditions, which companies are better prepared with their particular engine technology approaches, or whether gasoline or diesel tends to be more or less suited. For example, spark-ignition gasoline engines generally have higher CO and CO_2 emissions for a given engine size and performance characteristics, whereas compression-ignition diesels tend to have greater PM, NO_x, and N_2O emissions, but similar gram-per-mile standards are generally established nonetheless.

Table 2. Use of separate diesel and gasoline vehicle treatment in regulations

Regulation	Separate diesel and gasoline stringency?	Notes
US light-duty vehicles CAFE 1975-2009	No	No special diesel-gasoline treatment in CAFE requirements Considered but explicitly utilized “1.0 multiplier” for diesel
US light-duty vehicles CAFE/GHG 2012-2016	No	No special diesel-gasoline treatment in CAFE/GHG requirements Considered but did not include different diesel N_2O compliance
US light-duty vehicles CAFE/GHG 2017-2025	No	No special diesel-gasoline treatment in CAFE/GHG requirements Considered but did not include diesel technology multiplier
US light-duty vehicles Tier 2 emissions 2010-2014	No	No special diesel-gasoline treatment in NO_x, PM, NMHC, formaldehyde, evaporative control requirements
US light-duty vehicles Tier 3 emissions 2015-2025	No	No special diesel-gasoline treatment in NO_x, PM, NMHC, formaldehyde, evaporative control requirements
US heavy-duty vehicle and engine GHG/efficiency 2014-2018	**Yes**	Diesel 2018 CO_2 standards are 5%-6% more stringent than gasoline for given work factor for commercial pickups and vans; Special “engine service class” for spark-ignition gasoline engines
US medium-and heavy-duty engine emission standards 2007-2010	No	No special diesel-gasoline treatment in NO_x, PM requirements
EU light-duty vehicle emissions 2000-2014	**Yes**	Euro 3-5: ~3 times higher NO_x emission standard for diesels Euro 6 (2014): ~30% less stringent NO_x emission standard for diesels
EU light commercial emissions 2000-2014	**Yes**	Euro 3-5: ~3 times higher NO_x emission standard for diesels Euro 6 (2014): ~30% less stringent NO_x emission standard for diesels
EU medium- and heavy-duty engine emission standards	No	No special diesel-gasoline treatment in NMHC, CH_4, NO_x, and PM emission requirements
EU light-duty vehicle CO_2 2009-2015	No	No special diesel-gasoline treatment in CO_2 requirements
EU light commercial van CO_2 2009-2015	No	No special diesel-gasoline treatment in CO_2 requirements
China Phase 1-4 light-duty vehicle fuel consumption	No	No special diesel-gasoline treatment in fuel consumption requirements
China Phase 1-2 heavy-duty vehicle fuel consumption	No	No special diesel-gasoline treatment in fuel consumption requirements

CAFE: Corporate Average Fuel Economy; **GHG**: greenhouse gas; **NO_x**: oxides of nitrogen; **NMHC**: non-methane hydrocarbon; **PM**: particulate matter; **N_2O**: nitrous oxide; **CO_2**: carbon dioxide

The only exceptions, other than the US heavy-duty 2014-2018 GHG standards, where regulators opted to give special treatment to either gasoline or diesel are the European emission standards. For example, Euro V/5 NO_x standards for passenger vehicles and commercial vans were three times higher than for gasoline vehicles. One result of the relatively lax diesel NO_x standards in Europe is that low-NO_x diesel emission control technologies, including selective catalytic reduction with urea, were initially developed to help diesel models attain compliance with the NO_x standards in the United States where diesel is held to the same stringent standard as for gasoline. The EU standards reduced this gasoline-diesel discrepancy in the Euro VI/6 standards from three times higher to approximately 30% higher for 2014 and beyond to partially balance this NO_x differential. As a result, the low-NO_x technology is being phased into the EU diesel fleet with a several-year time delay compared to the United States.

As introduced above, the US heavy-duty pickup and van CO_2 standards are another such example where different standards are set; however, they are set to be more stringent for diesel than gasoline. In CO_2 emission regulations where the standards are indexed to a functional attribute of some type (i.e., mass-based CO_2 in Europe, footprint-based CO_2 in US light duty), the US heavy-duty pickup and van CO_2 standards appear to be the only example where special gasoline and diesel CO_2 standards are established.

FUEL TYPE AND WORK FACTOR

An additional important factor related to market dynamics is that gasoline and diesel vehicles are by and large segregated within this heavy-duty pickup and van segment due to technology factors and the broader market dynamics. As illustrated by Figure 6, gasoline vehicles are generally at lower payload and towing capacity (i.e., 82% below 5250-lb work factor), whereas diesel vehicles are higher work functionality (i.e., 80% at or above 5251-lb work factor). The heavily marketed truck specifications of torque, payload, and towing characteristics are critical market drivers for prospective vehicle purchasers, especially considering that heavy-duty pickup and van consumers have no consumer label data on vehicle efficiency. Thus, gasoline engines dominate the lower range of work factor, and diesel dominates the upper range of higher work factor. In essence, the work factor provides a way to index CO_2 standards to vehicle functionality; however, simultaneously overlaying separate gasoline and diesel standards allows gasoline vehicles to continue to produce higher CO_2 and have lower work functionality.

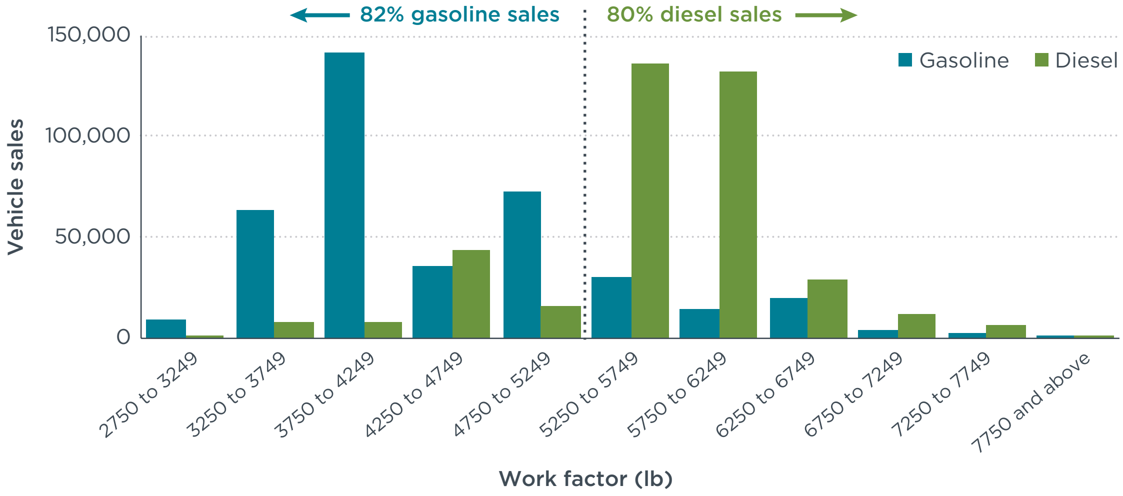

Figure 6. Sales breakdown of gasoline and diesel heavy-duty commercial pickups and vans by work factor

IV. TECHNOLOGY AVAILABILITY

As introduced above, required CO_2 emission levels for model year 2014-2018 pickups and vans are indexed to a work factor metric that incorporates the payload, towing, and four-wheel-drive capabilities, and also are set separately for gasoline and diesel vehicles. As a result, the standards are established in a manner that is intended to encourage additional efficiency technology in gasoline and diesel vehicles — but not to give any regulatory credit or inducement to influence shifts upward or downward in vehicle capability or fuel type that would impact CO_2 emissions. Therefore the question of the regulatory stringency is directly connected to technology availability and the effectiveness of the emerging efficiency technologies in delivering reductions in CO_2 emissions.

As shown in Figure 5**,** heavy-duty pickups and vans are required to reduce CO_2 by an estimated 10% (for gasoline) and 5% (for diesel) in the 2018 time frame. On a sales-weighted average basis and assuming the same fleet mix, the regulatory standards for model year 2018 would reduce the CO_2 emissions and fuel consumption of the combined gasoline and diesel vehicle fleet by 7.5%. In the initial rulemaking, the agencies noted the availability of many technologies that could result in greater CO_2 reductions in these pickups and vans; however, they indicated the manufacturers' forecast redesign schedules as notable factors in their assessment that limited the regulatory requirements to well below the full technology potential.

PHASE I REGULATORY DISCUSSION ON PICKUP AND VAN STRINGENCY

There was some disagreement among stakeholders regarding the final stringency of the gasoline and diesel standards in the 2014-2018 rulemaking. A group of stakeholders including nongovernmental organizations, public agencies, and policymakers found that the heavy-duty pickup and van standards could be made more stringent. These stringency arguments were based on the high technology potential (e.g., from the National Research Council, 2012) and how many common technologies in the pickup and van classes are being deployed for light-duty vehicles. The American Automotive Policy Council, representing vehicle manufacturers Chrysler, Ford, and General Motors, indicated that going further than the agencies' 2018 stringency would be problematic. They cited the uncertain baseline data on which the regulatory analysis was based, how some of the possible NAS technology was already in the fleet, and how many of the more advanced technologies like hybridization are less cost-effective.

EPA and NHTSA responded to the commentary that called for greater stringency with the following note:

> "Commenters arguing for more stringent standards cited the heavy-duty vehicle NAS study (and an associated TIAX report) finding that technologies such as hybridization are feasible. However, in the ambitious timeframe we are focusing on for these rules, targeting as it does technologies implementable in the HD pickup and van fleet starting in 2014 and phasing in with normal product redesign cycles through 2018, our assessment shows that the standards we are establishing are appropriate. More advanced technologies considered in the NAS report would be appropriate for consideration in future rulemaking activity."
>
> (US EPA and NHTSA, 2011a)

Since the initial 2011 Phase 1 heavy-duty rulemaking, new vehicle manufacturer technology reports, new research literature, and a new docket of regulatory-technical analysis are now available to help assess advanced efficiency technologies for pickups and vans. Since the completion of the Phase 1 heavy-duty standards, the light-duty CO_2 emission and fuel consumption rulemaking for model years 2017-2025 has been finalized. Its associated technical analyses and industry consultation provide a wealth of technical information to help inform on the questions of advanced technology availability in the 2020-2030 time frame. In addition, technology deployment announcements from vehicle manufacturers indicate positive developments for increased efficiency in full-size pickups and vans.

LIGHT-DUTY AND HEAVY-DUTY PICKUP AND VAN TECHNOLOGY

To provide additional context for assessing the viability of technologies for pickups and vans, this section analyzes and quantitatively compares the efficiency regulation stringency within the light- and heavy-duty standards. In order to compare the fleets, this analysis draws directly from the baseline datasets from the two rulemakings, then analyzes the required reductions according the vehicles' attributes. Namely, the regulatory requirements for the heavy-duty standards through model year 2018 are determined by the work factor (as described above), and the vehicle footprint determines the regulatory requirements under the light-duty standards. Here, as above, only large pickups and vans were included from the larger light-duty vehicle dataset.

Figure 7 illustrates the full spread of the agencies' baseline databases of vehicle models' CO_2 emissions, baseline sales weighted CO_2 emissions, and the required reductions under the adopted regulatory CO_2-reduction requirements for those vehicles' particular work factor and footprint attributes. As shown in the top pane of the figure, there is very little overlap in the categories' GVWR, as this is the differentiating attribute for the light- and heavy-duty vehicle pickups and commercial vans (although a relatively small number of medium duty passenger vans that are above 8500 lb GVWR are covered in the light-duty program). The bottom pane in Figure 7 shows there is significant overlap in the light- and heavy-duty pickups and vans in terms of the work factor, the defining regulatory attribute for the commercial pickup and van CO_2 emission standards. As noted above, the regulatory test CO_2 emission data for light-duty pickups and vans is from a lighter test weight protocol; therefore, those data would move up on the vertical axis, but remain at the same work factor, if they were tested as heavy-duty vehicles. The figure also shows the work factor-based 2018 gasoline and diesel CO_2 standards, which run through many of the baseline model year 2010 light- and heavy-duty pickup and van data points.

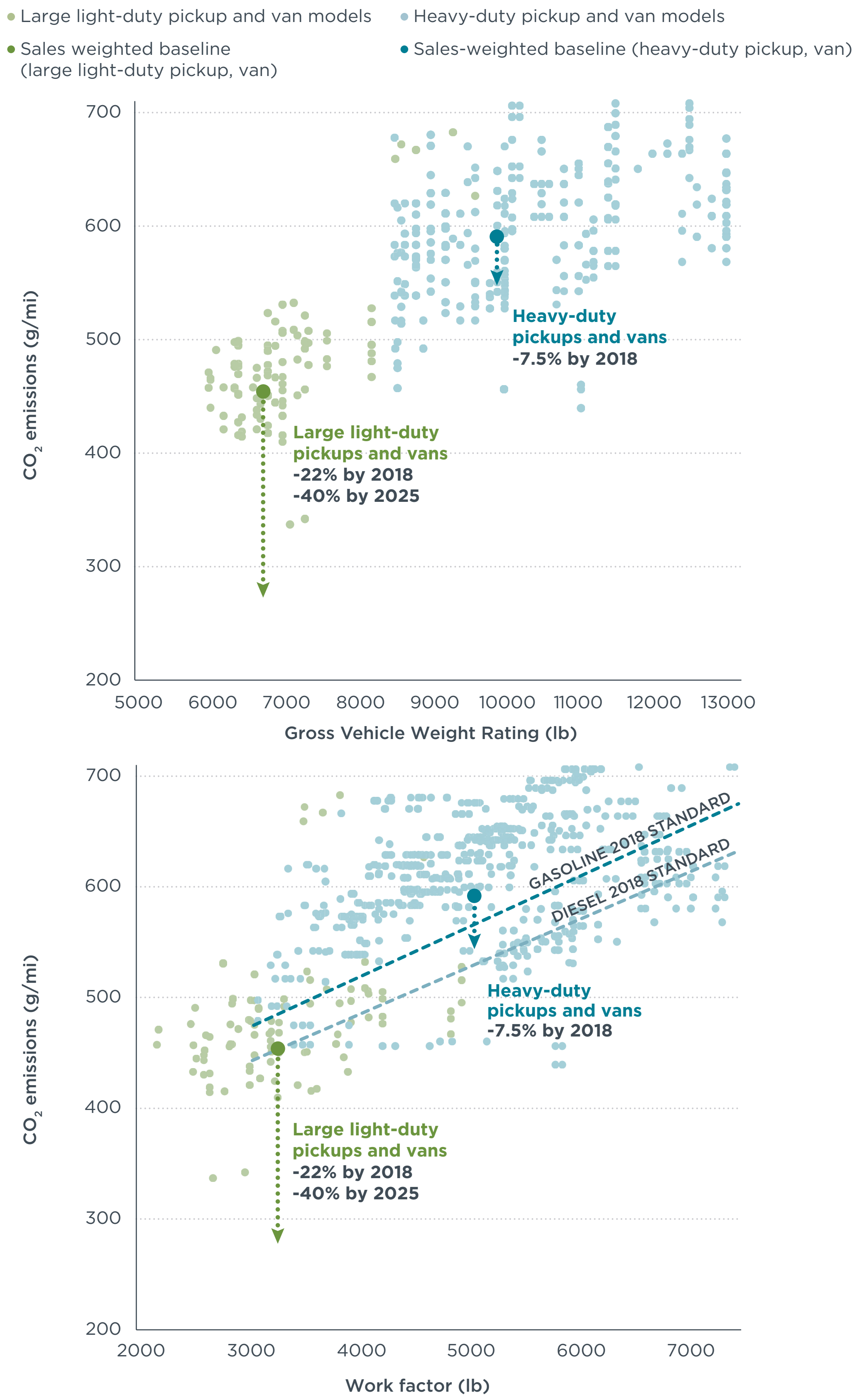

Figure 7. Baseline light- and heavy-duty pickup and van CO_2 emissions versus GVWR and work factor and required CO_2 reductions for adopted regulations

As illustrated in Figure 7, for a given set of attributes, large light-duty pickups and vans will reduce their test cycle CO_2 emissions by approximately 23% by model year 2018 and by 40% in model year 2025 to comply with the standards. This compares with the commercial pickup and van requirements for model year 2018 to reduce CO_2 emissions by approximately 7.5%, based on the agencies' baseline sales-weighted vehicle data. It is noted that in evaluating the percent improvements to meet future standards, air conditioning crediting provisions have been accounted for and these figures are only reflecting changes in test cycle CO_2 emissions. If the light-duty air conditioning credits of up to 24.4 g/mile CO_2 equivalent were included, the required light-duty CO_2 reduction for 2025 would be 45%, instead of 40%. As indicated, the light-duty standards require large pickups and vans, for a given fleet mix, to reduce CO_2 well outside the current models' CO_2 performance. On the other hand, commercial pickup and van CO_2 reductions stay well within CO_2 emission performance of existing models.

EFFICIENCY TECHNOLOGY FEASIBILITY

Efficiency technologies for vehicles are constantly being developed for all vehicle classes by all competitive original equipment manufacturers and component suppliers. But due to many factors related to technology budgets, volume of vehicle sales, and market dynamics, many vehicle technologies are developed first for gasoline light-duty automobiles and diesel heavy-duty tractor-trailer applications. Then applicable technologies sometimes migrate to the medium-duty and vocational sectors that tend to be lower volume and more specialized and diverse in their use.

Full-size pickups and vans are currently seeing major investments in engine, transmission, lightweighting, tires, and aerodynamic technologies, in large part due to companies' plans for compliance with the light-duty vehicle efficiency standards. The commercial truck models are cousins of the heavier light-duty pickups and vans, and they include primarily a mix of gasoline and diesel engines and share many of the same parts and engineering. The vehicles see many innovations from the higher-volume light-duty sector, which has seen steady efficiency technology infusion. These vehicles also include major diesel engine innovations, as well as many new emerging natural gas technologies. As a result, it is important to analyze the full-size pickup and van technology feasibility and cost-effectiveness in the context of the next phase of the heavy-duty standards. In the case of commercial pickups and vans, much of the efficiency technology evolves and migrates up from the higher-volume light-duty full-size pickups and vans, especially for gasoline engines.

For gasoline efficiency technologies, there is a long history of incremental efficiency technologies working their way from premium luxury and high-performance automobiles to sport utility vehicles, then to larger light trucks, and finally to more cost-conscious vehicle segments. Consumer demand for automotive performance and efficiency tend to bring many advanced technologies into the higher volume light-duty fleet first, before the technologies make their way to the lower-volume specialized trucks for commercial fleets. For example, efficiency technologies for engines (e.g., dual overhead cams, variable valve timing), transmissions (e.g., torque convertor lock-up, 6-speed transmissions), and others have migrated upward into larger full-size light truck classes (US EPA, 2013). In addition, vehicle lightweighting technologies have run through a similar migration, as evidenced by high-strength steel, aluminum, and unibody construction moving upward from various car models to larger vehicle types over the years (Lutsey et al, 2010).

The next slate of light-duty efficiency technologies, including downsized turbocharged engines, direct injection, further lightweighting, stop-start powertrains, dual-clutch transmissions, and active aerodynamic aids, also have the potential to diffuse upward into larger full-size vehicle classes. Ford's recent announcements with its EcoBoost (i.e., a downsized, turbocharged, direct injection) and lightweighting technologies confirm this point. First, Ford's 3.5-liter EcoBoost technology will become the exclusive engine option in the new model year 2015 Expedition (replacing the 5.4-liter engine). The model year 2015 Ford F150 full-size pickup will offer the second-generation 2.7-liter engine EcoBoost technology, an aluminum body redesign that achieves approximately 700 lb lower curb weight, and stop-start technology (Ford, 2014a). This full-size pickup redesign of the highest-selling light-duty vehicle in the United States achieves a 12%-14% mass reduction, which is approximately twice what the EPA and NHTSA projected for the entire light-duty fleet by model year 2025.

Ford is indicating that these technologies are migrating upward into Ford's medium-duty vehicles. The EcoBoost technology is being applied to the all-new model year 2015 Transit medium-duty vans, resulting in a 46% highway and 40% city fuel economy benefit over the outgoing E-Series model (Ford, 2014b). And industry experts' analysis of Ford indicate that the lightweighting technology similarly will migrate up to the heavier duty classes: "The next generation Ford-250/350 Super Duty is scheduled to launch around February 2016 and will share the T3 platform to allow for economies of scale in purchasing, advanced manufacturing and build processes. It is likely to feature extensive commonality with the light-duty F-150 and apply mass-reduction lessons learned from it," according to Wernie (2014). Ford has confirmed the use of its aluminum body technology for its Super Duty trucks in its Ford 2020 Vision report to investors (Ford, 2014c).

Other companies are also, to some extent, taking advantage of light-duty technology growth and volume and deploying their viable efficiency technologies into medium-duty classes. For model year 2014, Chrysler is rolling out its Hemi cylinder deactivation technology on its Dodge 2500 and 3500 models in its 6.4-liter (but not the 5.7-liter) gasoline engines (Williams, 2013). The Ram ProMaster commercial van is equipped with an automated manual transmission (Ram Commercial, 2014).

Most of the new crop of European body style vans, like the ProMaster, the Ford Transit, Nissan NV, and Mercedes-Benz Sprinter, are offering downsized or turbocharged V6 or in-line 4-cylinder diesel engines. Daimler's commercial vans are also proving out the viability of the deployment of light-duty efficiency technologies in heavy-duty applications. As of model year 2015, the standard transmission on its Mercedes-Benz Sprinter commercial vans is a 7-speed automatic with torque convertor lock-up and a low-friction rear axle. The Mercedes-Benz powertrain technology involves a downsized, two-stage turbocharged diesel engine, with dual overhead cams and four valves per cylinder, that delivers an 18% increase in fuel efficiency over the previous V6 with a 5-speed transmission. The vehicle engine also has a regulated fuel pump for optimal fuel supply and engine pressure and efficient accessories (air conditioning clutch, alternator, actuated steering) (Mercedes-Benz, 2014). Mercedes has also had start-stop technology on their Sprinter Vans in Europe since 2009 (Abuelsamid, 2009).

GM's new model year 2014 "EcoTec3" 5.3-liter and 6.2-liter light-duty gasoline engines have direct injection and cylinder deactivation (its Active Fuel Management system). These engines offer greater power and torque than many of the heavy-duty General

Motors model offerings. For example, GM's standard heavy-duty pickup offering is the 6.0-liter gasoline engine with less technology (i.e., without direct injection or cylinder deactivation) that provides 360 hp and 380 ft-lb torque as standard. However, the application of direct injection and cylinder deactivation efficiency technology on GM's light-duty 5.3-liter (355 hp, 380 ft-lb) and 6.2-liter (420 hp, 460 ft-lb) engine technology is not yet used in the heavy-duty applications.

The effect of the new light-duty engine technology improvements is substantial. According to the EPA (2010) database, the lower-technology Chevrolet 2500 6-liter heavy-duty pickups achieve tested fuel economy of 13/21 mpg city/highway. The model year 2014 Chevrolet 1500 light-duty pickups achieve city/highway tested fuel economy of 20/32 mpg (5.3-liter) and 18/29 mpg (6.2-liter) — achieving approximately 45%-50% greater fuel economy than the heavy-duty counterpart with the same or greater torque (US EPA, 2014). GM offers its Active Fuel Management system on its 5.3 and 6.2-liter engines. According to GM, the system delivers 7.5% fuel economy benefit and is estimated to cost only from $50-$100 per vehicle (Truett, 2014). Whether or when GM might offer its more efficient engines in its commercial pickups and vans is unclear.

Beyond the abovementioned developments by the major commercial van and pickup manufacturers, several major new sources for efficiency technology data are available that update the heavy-duty Phase 1 rulemaking analysis. As part of the 2011-2012 analysis that was conducted as part of the 2012-2016 and 2017-2025 light-duty vehicle greenhouse gas rulemakings, the regulatory assessment included extensive investigation of efficiency technologies, their effectiveness, and the associated costs by vehicle class. The work had the additional value of multiple consultations with automakers to understand technology developments in the large light truck segment, including full-size vans and pickups, in the 2025 context. These companies include the same companies that are developing and deploying efficiency technologies in the full-size commercial vans and pickups that are subject to the heavy-duty regulation.

As part of the light-duty regulatory process several major new expert engineering studies were conducted on efficiency technologies and their costs. In particular the peer-reviewed technical vehicle simulation analyses of Ricardo quantified the potential for advanced powertrain technologies to reduce fuel consumption (Ricardo, 2011). The gasoline engine efficiency technologies include direct injection, turbocharging, and exhaust gas recirculation (EGR), which are already common on diesel engines. A series of engineering teardown studies assessed the associated efficiency technologies' manufacturing cost (FEV, 2011a, 2011b, 2013a, 2013b). These studies were largely used in the EPA, NHTSA, and CARB rulemaking for 2017-2025 standards for light-duty vehicles (US EPA and NHTSA, 2012; CARB, 2011). Further, the rulemaking, engineering teardown and crashworthiness analyses have since informed on the potential of lightweighting technologies (FEV, 2012; EDAG, 2011, 2012; Lotus, 2012; Singh, 2012). These studies made substantial improvements over previous attempts to assess emerging and in-development efficiency technologies in the 2025 timeframe with increased technical rigor, largely embodying the principles set forth by the National Research Council on improved rigor, transparency, and peer review (NRC, 2011). In addition, the technical study by Stanton (2013), based on diesel engines in vocational medium-duty and highway heavy-duty diesel applications, provides estimates for engine efficiency improvements for diesel engines.

Table 3 summarizes the individual efficiency technologies for gasoline engines, diesel engines, transmissions, vehicle load and accessories, and hybrid systems. As shown for engines, both gasoline and diesel engine technologies have great potential to increase efficiency and reduce fuel consumption. The fuel consumption reductions are all shown from baseline 2008-2010 vehicles that do not include those listed technologies, and the technologies listed are not simply additive, as their efficiency is calculated in simulation models and lumped parameter tools that capture the technologies' interactions. Based on the Ricardo (2011) and EPA and NHTSA (2012) work, large full-size pickups and vans with gasoline engines can reduce vehicle fuel consumption by approximately 23.5%. Based on the work of Stanton (2013), diesel engines can achieve up to a potential 18% reduction in fuel consumption from advanced efficiency technologies listed in the table. Analysis by the Southwest Research Institute (SwRI) indicates similar results, and, in the cases of turbocharged gasoline downsizing, gasoline cylinder deactivation, diesel engine friction reduction, and EGR improvements, greater fuel consumption reduction than indicated in the table appears to be feasible (SwRI, 2014). Note that, due to diesel engines' common use of turbocharging, direct injection, and EGR, the result of these advancements on gasoline engines would offer the potential to reduce the efficiency gap between diesel and gasoline engines.

Table 3. Potential fuel consumption reduction from pickup and van efficiency technologies

Area	Technology	Fuel consumption and CO_2 reduction[a]	Potential applicability to commercial vehicles	
			Gasoline	Diesel
Gasoline engine	Engine friction reduction (2.5%)	2.4%	✓	
	Engine friction reduction (3.5%)	4.2%	✓	
	Cylinder deactivation	5.7%	✓	
	Discrete cam phasing (DCP)	4.9%	✓	
	Discrete variable valve lift (DVVL)	4.9%	✓	
	sGDI (18-bar, 33% downsize)	13.6%	✓	
	sGDI+DCP+DVVL (18-bar, 33% turbo downsize)	16.8%	✓	
	cEGR sGDI+DCP+DVVL (27-bar, 56% turbo downsize)	23.5%	✓	
Diesel engine	Engine downspeeding	1.7%-2.4%		✓
	High-efficiency NO_x aftertreatment	1.8%-2%		✓
	Lubricant viscosity	0.3%-1.5%		✓
	Turbomachinery efficiency	1.4%		✓
	Variable flow oil, water pump	0.6%		✓
	Reduced exhaust gas recirculation (EGR)	0.6%		✓
	Ports, air compressor, EGR dual phase	0.7%-1.1%		✓
	Friction reduction	0.6%-0.9%		✓
	Reduced heat transfer	1.4%		✓
	Compression ratio	0.7%-1.1%		✓
	Reduced engine backpressure	0.7%		✓
	Aftertreatment thermal management	2.9%		✓
	Diesel engine efficiency (above technologies)	12%-18%		✓
Transmission	Torque convertor lock-up	0.5%	✓	✓
	Aggressive shift logic	2.4%	✓	✓
	High efficiency gearbox	4.3%	✓	✓
	Optimized shifting	6.2%	✓	✓
	Active powertrain optimization	3%-4%	✓	✓
	6-speed automatic	2.1%	✓	✓
	8-speed automatic	7.8%	✓	✓
	Wet dual clutch 8-speed[b]	11.9%	✓	✓
	Dry dual clutch 8-speed[b]	12.6%	✓	✓
	Continuously variable[b]	-	✓	✓
Vehicle load and accessory	Low drag brakes	0.8%	✓	✓
	Secondary axle disconnect	1.6%	✓	✓
	Electric power steering	0.8%	✓	✓
	Improved accessories	3.5%	✓	✓
	Mass reduction (10%)	5.1%	✓	✓
	Mass reduction (20%)	10.4%	✓	✓
	Tire low rolling resistance (10%)	1.9%	✓	✓
	Tire low rolling resistance (20%)	3.9%	✓	✓
	Aerodynamics (10%)	2.3%	✓	✓
	Aerodynamics (20%)	4.7%	✓	✓
Hybrid systems	12V stop-start	3.6%-6.5%	✓	✓
	High-voltage belt-alternator	8.0%	✓	✓
	Parallel hybrid (23-40 kW electric motor size)	31.9%	✓	✓

CO_2 = carbon dioxide; cEGR = cooled exhaust gas recirculation ; sGDI = stoichiometric gasoline direct injection

[a] Based on large light truck fuel consumption from EPA and NHTSA, 2012, and diesel engine efficiency technologies from Stanton, 2013; Also see Kromer et al, 2009; SwRI, 2014

[b] Technologies not included in EPA and NHTSA 2017-2025 technology packages for large light-trucks

Table 3 shows the viability of many efficiency technologies for potential fuel consumption reduction in pickups and vans in the 2025 timeframe. The combined impacts from engine, transmission, and vehicle technologies are estimated via simulation and lumped parameter modeling to capture the system interaction effects (from US EPA, 2012). For example, the 23.5% from the advanced gasoline engine package includes turbocharging, direct injection, cooled exhaust gas recirculation, and advanced valve actuation. A transmission package that includes eight speeds, optimized shifting strategy, torque converter lock-up, and a high-efficiency gearbox reduces fuel consumption by more than 18% compared to a baseline 4-speed automatic 2010 baseline transmission. Road load reductions, including a 15% reduction of aerodynamic drag, tire rolling resistance, and vehicle mass, together result in a 14% vehicle fuel consumption reduction. Each of these efficiency technology improvement areas greatly exceeds the overall Phase 1 model year 2018 requirements (i.e., 10% for gasoline and 5% for diesel, see Figure 5). As a result, the vast majority of these efficiency technologies are still viable for 2018 and beyond deployment for any potential future regulatory requirements.

Figure 8 summarizes how EPA's lumped parameter heavy-duty commercial pickup and van results (from the 2014-2018 heavy-duty rulemaking) compare with EPA's lumped parameter large pickup and van results (from the 2017-2025 light-duty rulemaking). The results are selections of technology packages from EPA's lumped parameter models (US EPA, 2011b; US EPA 2012). The upper part of the chart, from the heavy-duty commercial pickup and van analysis, shows the full extent of technologies considered by the agencies for the 2014-2018 regulations. The lower part of the chart, from the large light-duty pickup and van lumped parameter modeling, shows a selection of technologies that offer great potential for commercial applications in the 2025 timeframe. The marked differences in the EPA lumped parameter model for the 2018 heavy-duty analysis (US EPA 2011b) and the lumped parameter model for the 2025 light-duty analysis (US EPA, 2012) give an indication of the types of the updates the agencies could make for the next phase of the heavy-duty regulations. The 2025 technology packages shown exclude more advanced and more expensive applications with discrete variable valve lift, stop-start, hybridization, and 20% mass reduction that were also included in the light-duty rulemaking analysis. As shown, the light-duty large pickup and van efficiency packages shown can achieve 45%-47% fuel consumption and CO_2 reduction from the 2010 reference technology.

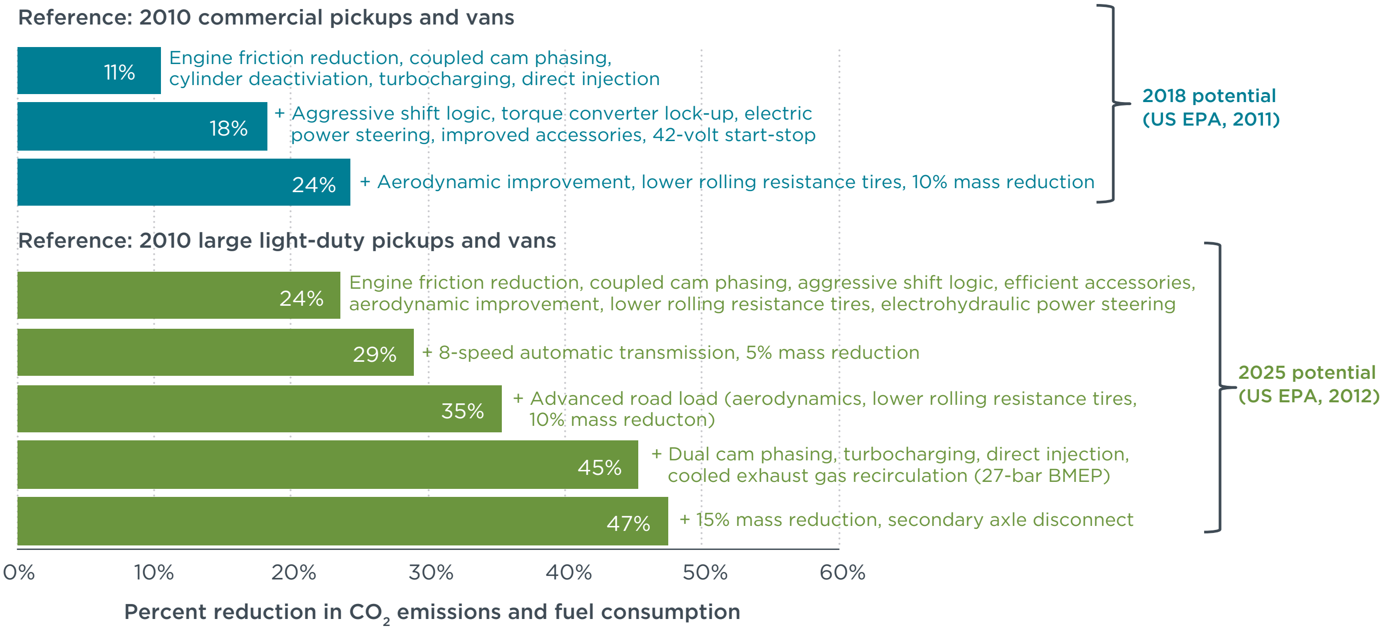

Figure 8. Efficiency technology packages for pickup and van CO_2 and fuel consumption reduction from commercial 2014-2018 (US EPA, 2011b) and light-duty vehicle 2017-2025 (US EPA, 2012) rulemaking analyses

EPA and NHTSA also investigated the associated technology costs to increase the efficiency of large pickups and vans within the light-duty rulemaking. Figure 9 illustrates the incremental technology price increase associated with the increased introduction of various engine, transmission, accessory, and road load efficiency technologies (US EPA, 2012). The technology-attributable CO_2 reductions and incremental technology price are based on 2010 baseline vehicles of EPA's largest light truck categories; these baseline vehicle categories are based on 5- to 6-liter gasoline engines, 5,000-5,400 lb average vehicle curb weight, various V8 engines (dual overhead cam 4-valve, single overhead cam 2-valve, single overhead cam 3-valve, and overhead valve 2-valve), 4-speed automatic transmissions and with technology applicability that was constrained due to their towing capacity requirements.

The figure shows the progression through technologies and indicates the percent CO_2 and fuel consumption reduction from several of these technology packages. The moderate technology packages achieve 20%-40% CO_2 and fuel consumption reduction at $900-$2,000 per vehicle. The more advanced technology packages achieve 40%-48% CO_2 and fuel consumption reduction at $2,000-$3,000 per vehicle. For context, the average commercial pickup and van requirement of a 10% CO_2 reduction for gasoline vehicles by 2018 is also shown.

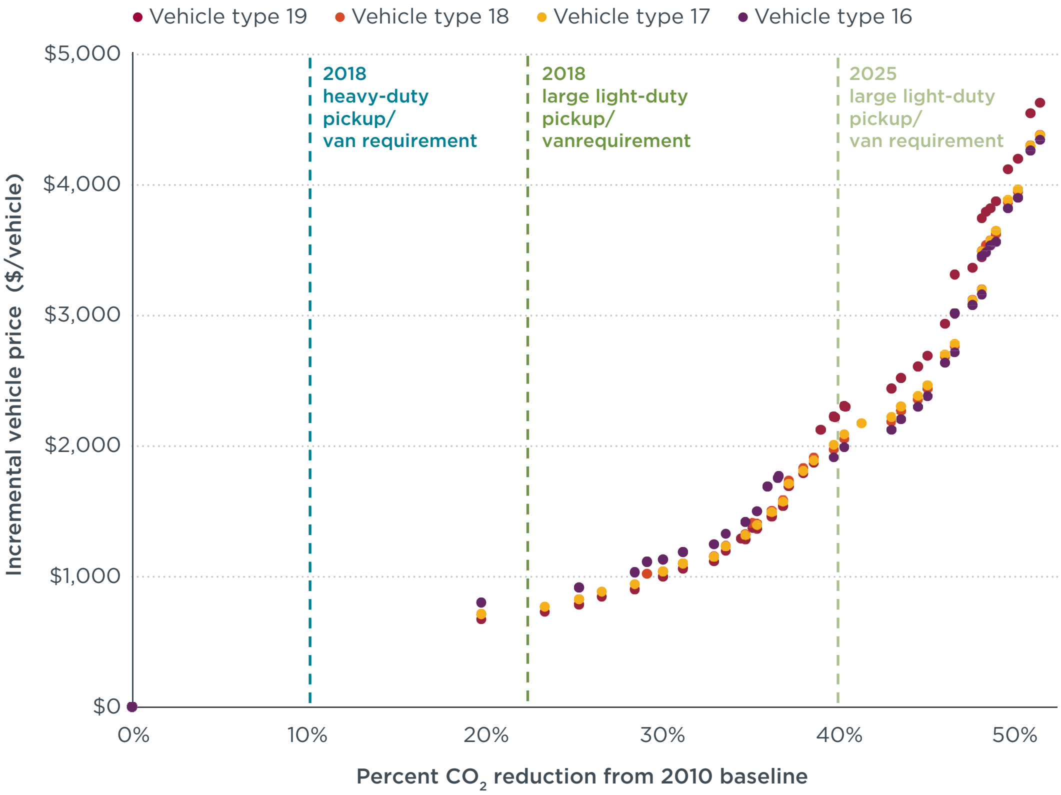

Figure 9. Incremental technology price versus CO_2 reduction from 2010 baseline for large pickups and vans in model year 2025 timeframe (from US EPA, 2012)

V. DISCUSSION

The preceding analysis offers an assessment of commercial pickups and vans to help inform some of the key regulatory questions about what the new data on large light-duty pickup and van efficiency technologies might mean for commercial trucks, and about whether a regulatory design that indexes stringency to fuel type (i.e., gasoline and diesel) is warranted. This section discusses both of these interrelated questions in reference to the 2020 and beyond heavy-duty pickup and van standards.

LIGHT-DUTY AND HEAVY-DUTY PICKUP AND VAN TECHNOLOGY DIFFERENCES

As noted in Table 1, Figure 4, and the accompanying text, there are differences in the large light-duty and heavy-duty pickups and vans, and these differences, in turn, affect the applicability of efficiency technology. Notably, the two vehicle classes are tested differently within the regulations. Both vehicle classes have the same basic test procedures for fuel economy and CO_2 emissions, based on the combined 55% city and 45% highway test cycles. However, the heavy-duty vehicles are tested with half their maximum load — generally about 1,500-2,500 lb, versus the additional loaded vehicle weight of 300 lb for light-duty pickups and vans. As a result, the quantitative comparisons above only refer to percent reductions, rather than absolute CO_2 gram-per-mile or mile-per-gallon results.

In addition, the applicability and precise CO_2 reduction opportunity from the various technologies could differ somewhat between heavy- and light-duty pickups and vans. Not all efficiency technologies are equally applicable in the light- and heavy-duty segments. For example, continuously variable transmissions have been proven to be viable only for smaller light-duty applications, with most deployments in smaller Honda, Nissan, Subaru, and Chrysler cars and small crossover vehicles. Technologies such as these and various other transmission technologies were omitted from the light-duty pickup and van consideration in the construction of technology packages in the 2017-2025 rulemaking analysis due to towing limitations. As a result, Figure 9 does not include the use of automated manual or dual-clutch transmissions. Other technologies may be less applicable based on their relative cost-effectiveness. Per the preceding analysis, the EPA and NHTSA analysis found efficiency packages that achieve up to 47% CO_2 reduction at less than $3,000 per vehicle, without yet applying discrete variable valve lift, stop-start, hybridization, and 20% mass reduction.

The latest information on engine, lightweighting, transmission, and mild hybrid technologies could help the agencies use their large light-duty pickup technology and cost relationships and consider updates per developments since the 2012 light-duty rulemaking. One such area is cylinder deactivation. The agencies did not predicate 2014-2018 standards on any deployment of cylinder deactivation. Yet, cylinder deactivation is now used on large GM and Chrysler gasoline pickup trucks. The agencies indicated "effectiveness improvements scale roughly with engine displacement-to-vehicle weight ratio." Based on the analysis in Table 1 from agency data (i.e., from US EPA, 2010), Class 2b pickups and vans have 20% lowerlower displacement-per-test weight than their light-duty full-size pickup and van counterparts. For Class 3 pickups and vans the difference is 30%. According to GM, its cylinder deactivation system (now offered on its 5.3 and 6.2-liter engines), delivers 7.5% fuel economy benefit, and is estimated to only cost from $50-$100 per vehicle (Truett, 2014). Therefore the agencies' large light truck benefit or

5.7% CO_2 reduction already approximately reflects the scaling down of efficiency for the largest engine engines and does not require the 20%-30% displacement-to-vehicle scaling. Also the agencies' estimated cost of the cylinder deactivation system of about $200 (US EPA, 2012) appears to be a significant overestimate of the long-term cost of the technology.

For transmission technologies, the agencies included only a subset of transmission technologies in the original heavy-duty rulemaking. Based on EPA and NHTSA's analysis on large light-duty trucks, considerably more potential technology is available. For example selecting all the transmission technologies (aggressive shift logic, torque convertor lock-up, 8-speed transmission) in the heavy-duty lumped parameter model nets a 7% CO_2 reduction (US EPA, 2011b). Per the EPA (2012) light-duty lumped parameter modeling, including similar technologies would at least double the CO_2 benefit from transmission technologies from the previous Phase 1 heavy-duty tool, and including automated manual transmission (AMT) and dual-clutch transmission (DCT) technology would go further yet. Although automated manual and dual-clutch transmissions for heavy-duty still could need a torque converter due to towing requirements, the efficiency benefits are significant enough to be pursued by leading truck transmission suppliers. At this time, AMT and DCT technology is being deployed in mid-sized light-duty vehicles, full-sized commercial vans, and in medium- and heavy-duty truck applications (US EPA, 2013; Chrysler, 2014; Lutsey et al, 2014; Stoltz and Dorobantu, 2014). These more advanced transmission technologies are now being used in lower and higher payload, towing, and torque requirements than for commercial pickups and vans; therefore, they merit consideration for commercial pickups and vans.

Since the heavy-duty rulemaking, lightweighting technology has been investigated by the agencies and continues to see developments. The agencies indicated that heavy-duty pickups and vans receive less efficiency benefit from a given amount of lightweighting technology than their light-duty counterparts due to higher payload and their inability to downsize the engine. Therefore 10% lightweighting was valued at 3.2% fuel consumption reduction (compared to 10% lightweighting giving 5%-6% fuel consumption reduction in light-duty with lower test weight). As discussed above, the latest developments in full-size pickups are indicating that downsized engines paired with lightweighted vehicles are viable and can meet the power, torque, payload, and towing demands of many heavy-duty pickup and van consumers. Namely, Ford is offering a vehicle with extensive aluminum body and increased use of high-strength steel to achieve approximately 700 lb weight reduction in its 2015 F150 redesign and announced the use of such techniques in its future heavy-duty commercial vehicles (e Ford, 2014a-c). The most recent research indicates that lightweighting technology up to 15%-20% mass reduction can come at no, or nearly no, cost (FEV, 2012; EDAG, 2011, 2012; Lotus, 2012; Singh, 2012).

On the whole, it is clear that the commercial pickup and van models can largely see the same large light-duty truck efficiency packages as analyzed in the 2017-2025 rulemaking, with gasoline engine technologies seeing more potential efficiency improvement than diesel engines. What is not precisely clear is whether the inclusion of new research and new product developments in various powertrain, transmission, and road load technologies might make the technology CO_2-incremental technology price curve slightly higher or lower than large light truck classes (see Figure 9).

TOWARD HYPOTHETICAL FUEL NEUTRAL STANDARDS

Combining the points from above on efficiency technology availability and fuel neutral standards, we assess what a shift toward hypothetical fuel neutral standards might look like beyond the adopted 2018 CO_2 requirements for commercial pickups and vans. This section also discusses the potential benefits of such a shift to fuel neutral performance standards.

Figure 10 illustrates a hypothetical shift from the prevailing 2018 commercial pickup and van standards for gasoline and diesel trucks to fuel neutral CO_2 standards for future model years. Two hypothetical fuel neutral standards are indicated in the figure — one for a midterm standard in 2022, and one for a long-term standard that could apply for longer-term 2027 time frame. The effect and rationale for such standards is discussed below.

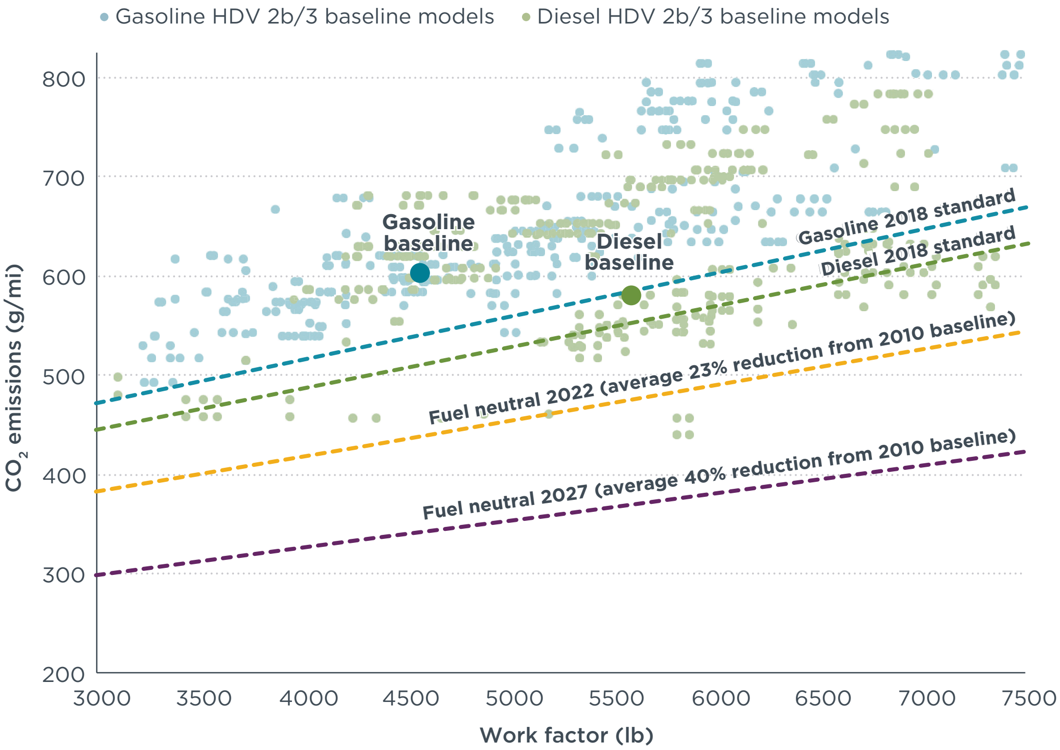

Figure 10. Baseline commercial pickups and vans and separate model year 2018 CO_2 standards for gasoline and diesel vehicles

The midterm standards are meant to bring the gasoline and diesel standards together for the second phase of standards. As a result, the differential impact from gasoline and diesel trucks is analyzed separately. As shown, the baseline sales-weighted average commercial trucks for 2010 are 602 gCO_2/mile for gasoline and 579 gCO_2/mile for diesel. The resulting overall change for heavy-duty pickups and vans from the baseline fleet in this scenario to achieve the suggested midterm target is 23% (27% for gasoline, 18% for diesel). The hypothetical midterm standard would amount to a 4.9%/year fuel consumption reduction from 2019-2022, and an overall 2.1%/year 2010-2022 rate of change. The low overall annual improvement is due to the heavy-duty program's comparatively modest changes through model year 2018 for Phase 1. The midterm 2022 CO_2 target line is defined by the following equation:

$$CO_2 \text{ target (in gram/mile)} = 0.03578 \text{ [work factor]} + 272.2$$

The longer-term 2027 timeframe would accommodate a two-year time lag from the technology rollout in the large light-duty vehicles to meet the 2025 standards. The adopted light-duty vehicle standards require CO_2 and fuel consumption reductions of a sales-weighted average 40% fuel consumption rate and CO_2 emission reduction for full-size large light trucks from 2010 through 2025, so this same fuel consumption change is assumed here as an potential long-term policy fuel consumption reduction. The resulting overall change for heavy-duty pickups and vans from the baseline fleet in this scenario is 40% (43% for gasoline, 36% for diesel). As illustrated above, the gasoline-specific technologies of turbocharging, direct injection, and cooled exhaust gas recirculation have the potential to greatly reduce the diesel-to-gasoline engine efficiency differences. The non-engine technologies (i.e., transmission, aerodynamic, lightweighting) are broadly applicable to both gasoline and diesel vehicles. This hypothetical long-term standard would amount to a 4.9%/year fuel consumption reduction from 2019-2027, and an overall 2.9%/year 2010-2027 rate of change. We note that these hypothetical heavy-duty standards would still be significantly less than the full technology potential that is indicated above (e.g., see Table 3 and Figure 9). The long-term 2027 CO_2 target line is defined by the following equation:

$$CO_2 \text{ target (in gram/mile)} = 0.02783\ [\text{work factor}] + 214.1$$

Based on this assessment of various technical and regulatory documents, the US Phase 2 heavy-duty vehicle engine and emission standards could benefit from shifting away from special diesel- and gasoline-specific standards for a number of reasons: international best practices, accelerated technology deployment, and greater environmental benefit.

Technology-neutral performance standards are a foundational best practice for vehicle efficiency and emission regulations in the United States and around the world. Performance standards, by definition, are not meant to pick technology winners. EPA has generally not been in the practice of playing favorites between diesel and gasoline in their rulemaking. Making the pickup and van standards fuel neutral would put these requirements back in line with most of their other regulatory programs. Establishing performance-based standards reasserts the principle of driving the lowest emission technologies, and it also critically corrects what can easily be seen by the outside world as a regulatory protection of domestic manufacture of gasoline-fueled vehicles.

The original Phase 1 pickup and van standards were simultaneously accommodating both the varying work functionality (i.e., through the work factor) *and* the different market positions of the various gasoline and diesel vehicles. This approach has had the clunky result of demanding little from diesels and protecting gasoline vehicles that are at higher CO_2 emissions and lesser "work factor" utility levels than their diesel counterparts. The Phase 2 standards can move past this transition period to establish standards that index truck efficiency to utility, without special treatment of any particular fuel types or for automakers that disproportionately specialize in them.

Adopting fuel neutral standards would offer several clear benefits in accelerating efficiency technology deployment, reducing carbon emissions, and reducing oil use. Fuel neutral standards would ensure that more of the available gasoline vehicle efficiency technology makes its way into the heavy-duty vehicle fleet. For example, currently the heavy-duty standards are far less stringent in annual percent stringency. The annual CO_2 improvement of 1% per year for heavy-duty pickups and vans compares to the 4% per year requirement for large light-duty pickups and vans over the 2010-2025 period. Similarly, the major technology gap can be seen in the in percent CO_2 change on a per-vehicle basis. Heavy-duty pickups and vans would only reduce CO_2 by 7.5% by 2018 versus large light-duty truck standards that mandate a 40% reduction by 2025 from their 2008-2010 baselines. Most light-duty gasoline efficiency technologies can migrate to their comparable heavy-duty models early within the Phase 2 standards. The technologies include advanced turbocharging, direct injection, cooled exhaust gas circulation, cylinder deactivation, engine friction reduction, low-drag brakes, efficient accessories, dual clutch transmission, stop-start, aerodynamic improvements, low-rolling resistance tires, lightweighting, and hybridization.

Despite some concerns, there is no evidence that fuel neutral standards will push gasoline engines from the marketplace. Some industry players that are developing their full portfolio of gasoline efficiency technologies for 40% CO_2 reductions in 2020-2025 for their light-duty pickups and vans have begun to voice questions about whether withdrawing gasoline-specific standards could force gasoline models out of the market. For example, one company makes the case that separate fuel standards are important to acknowledge market diversity and lower-cost gasoline vehicles (McAlinden, 2013). However, there is no evidence that such regulations have driven gasoline or diesel out of any market internationally. On the contrary, a common standard promotes the most cost-effective technologies in both fuel types.

The technology that is being deployed in light-duty pickups will be available well in advance of a potential heavy-duty Phase 2 2025-2030 timeline, and there appear to be more gasoline engine efficiency technologies available than diesel (see Table 3). In addition, gasoline and diesel engines play distinct and separate roles in this dynamic market for Class 2b and 3 heavy-duty trucks. As indicated in Figure 6, gasoline vehicles tend to dominate the lower payload and towing part of the fleet and diesels dominate the higher payload and towing part of the fleet. There is no reason or data to suggest that retaining the relatively more lenient gasoline truck CO_2 standards is needed or justified to protect gasoline pickups and vans. In fact, the rationale could be quite the opposite. By protecting gasoline trucks from competing on CO_2 grounds with diesel trucks, the regulations could, in the longer term, allow heavy-duty gasoline trucks to remain underdeveloped from a technology perspective and persist with significantly lower fuel economy and lower work characteristics.

There are additional oil-reduction and climate benefits to adjusting the commercial pickup and van standards for fuel neutrality. Developing fuel neutral standards that also account for a sales-weighted baseline of all models might also require that flatter work factor-indexed standards be adopted. Flatter utility-based regulatory standard lines would better ensure that diesel technology vehicles also advance more rapidly than the very small 5% benefit for Phase 1. Having a more gradual slope has the additional benefit of discouraging the increase of CO_2 emissions from shifts in sales upward in trucks' average work factor over time.

There is one more potential benefit of note: Fuel neutral CO_2 performance standards can better promote global industrial competitiveness of advanced gasoline engine technology. Based on the current market dynamics, gasoline engines would not be forced from the market with fuel neutral standards. In fact, pushing gasoline efficiency technology to perform at the same utility-based standard as diesel is critical if heavy-duty gasoline engines are to remain globally competitive in a marketplace that demands both high work functionality and high fuel efficiency. This is important for companies like GM, Chrysler, and Ford, which develop the gasoline engines for these heavy-duty pickups and vans and could opt to deploy more of their advanced light-duty gasoline efficiency technology into their heavy-duty models more rapidly.

VI. CONCLUSIONS

This report has sought to analyze new commercial pickup and van sales and efficiency technology data to inform the next phase of commercial pickup and van efficiency regulations. The assessment involves a novel analysis of regulatory vehicle data, updated sales data, technology developments, and state-of-the-art vehicle simulation data of full-size pickups and vans that have been published since the original 2014-2018 efficiency rulemaking. This study's main focus areas are to examine questions about the regulatory design and analyze the potential viability of various advanced efficiency technologies.

The findings of this report inform on baseline technology characteristics and the rate of technology improvement in large light-duty and commercial heavy-duty pickups and vans. The new data since the Phase 1 rulemaking reveal that commercial pickup trucks and vans share many similarities with their lighter counterparts, including their vehicle size, work attributes, and technology availability. As analyzed above and illustrated in Figure 7, the findings indicate that the light-duty efficiency standards are pushing efficiency technology at a much greater rate, potentially setting the stage for equivalent progress in the heavier segment. To achieve the adopted standards, heavy-duty commercial pickups and vans are required to reduce their exhaust CO_2 emissions up to 10% by 2018, whereas the large light-duty pickup and van counterparts face a 40% exhaust CO_2 emission reduction by 2025.

In addition, the findings indicate that neither international precedent nor US market considerations support the need for separate gasoline and diesel standards. The prevailing regulatory design artificially protects gasoline commercial pickups and vans from regulatory CO_2 competition against diesels that, on average, have 4% lower CO_2 emissions and 22% higher work factor capacity. The analysis above and Figure 5 show this disparity in the baseline spread and sales-weighted averages of the gasoline and diesel models' CO_2 emissions, and the gasoline models' less stringent standards. This analysis indicates that heavy-duty gasoline engines have more ongoing developments and technology potential to improve efficiency than diesel engines, eliminating the need to continue separate fuel-based standards.

Based on this assessment, we make several recommendations and discuss several areas for further analysis related to the ongoing rulemaking toward standards for commercial pickups and vans in the 2020 and beyond timeframe.

Recommendation #1. Establish commercial pickup and van CO_2 emission and efficiency standards that are as technology-forcing as the light-duty vehicle standards. To achieve the adopted standards, heavy-duty commercial pickups and vans are required to reduce their exhaust CO_2 emissions by up to 10% (by 2018), whereas the pickup and van counterparts in the light-duty vehicle segment are primed for a 40% CO_2 emission reduction (by 2025). Setting the post-2020 commercial pickup and van standards to be as technology-forcing as the light-duty standards for large pickups and vans would include at 4%-5% per year reduction in CO_2 emissions through 2025-2030, applying technologies similar to those being deployed in full-size light-duty pickups and vans.

Based on the assessment above there appear to be many viable technology paths for commercial pickups and vans to substantially increase efficiency and lower CO_2 emissions. Engine improvements to reduce CO_2 emissions — by up to 24% for gasoline and by 18% for diesel — would capitalize on the leading technology innovations. Further, advances in transmission efficiency would reduce CO_2 by more than 10%. Including vehicle road load reductions (i.e., in aerodynamics, tires, and lightweighting) would reduce commercial pickup and van CO_2 emissions by approximately 14%. These cost-effective technologies together offer the potential to reduce fuel consumption by 40%, before considering hybridization. These efficiency technologies far surpass the Phase 1 pickup and van regulatory requirements for model year 2018 and are similar to companies' existing efforts for their full-size pickups and vans.

If future commercial pickup and van CO_2 and efficiency standards are not developed with similar stringency to that of light-duty — in percentage, not absolute, terms — there would be several consequences. Beyond the missed opportunity to bring emerging technologies into the fleet, keeping lax commercial truck standards would provide a persistent incentive to vehicle manufacturers and consumers to drift upward to heavier vehicles with lower efficiency. As of model year 2010, there were about 100,000 light-duty pickups and vans sold that were above 7,000 lb (and another 500,000 above 6,500 lb) GVWR that could migrate into the heavy-duty vehicle category. The fact that nearly no 7,500 to 8,500 lb GVWR vehicles were sold shows how easily migration upward into the heavy-duty vehicle category occurs, even while physical characteristics like weight, footprint, and work factor remain similar. Making similarly technology-forcing standards means progressing the heavy-duty standards at least 4% per year from 2020 on to stay on a parallel CO_2 trajectory with the light-duty sector. This will approximately maintain the same efficiency gap between passenger light trucks and commercial light trucks, and allow efficiency technologies to enter the heavy-duty fleet several years after they are widely deployed in the light-duty fleet.

Recommendation #2. Make commercial pickup and van CO_2 emission and efficiency standards fuel neutral for 2020 and beyond.

Developing fuel neutral commercial pickup and van performance standards that require the same level of emissions for a given level of functionality, without regard to fuel type, will (a) most equitably and cost-effectively promote low-carbon technology; (b) be in accord with the general international principles on technology-neutral performance standards; (c) be consistent with the US light-duty standards for pickup trucks and vans; (d) help ensure gasoline-focused companies are developing competitive and efficient vehicles in this class; and (e) better protect against upward shifts in trucks' average work factor over time that will otherwise erode regulatory program benefits. Figure ES-2 illustrates hypothetical post-2020 fuel neutral standards that would remove the artificial protection of gasoline engines from the existing US commercial pickup and van standards. Due to the greater potential of gasoline engine technologies, as analyzed here, such a regulatory design change to fuel neutral standards will not disadvantage gasoline-fueled vehicles. Such an approach would establish a technology-forcing program that addresses market dynamics and allows companies to cement their technology leadership in this US market segment.

The United States has led the world by demanding that diesels be held to the same NO_x and particulate emission standards as gasoline vehicles of the same class and function; ideally the United States would do the same for efficiency and CO_2 emission regulation. Technology and fuel-specific standards inherently protect one technology from another. In the current case, the US heavy-duty vehicle regulatory standards are isolating gasoline commercial pickups and vans from competing with diesel-fueled trucks. The European Union historically allowed more lax NO_x emission regulations for diesel vehicles, and this is not an example to follow. Maintaining this gasoline-diesel separation could similarly open the US regulation up to suspicion that the government is protecting domestic manufacturing companies, which encourages other countries to do the same in their regulations. It also inhibits prominent US-based companies from making major investments and exerting greater efficiency technology leadership in this segment. The separate regulatory treatment in the first phase of US heavy-duty vehicle standards, where gasoline vehicles were permitted lower efficiency for the same work factor, may have had a purpose initially, but continuing this policy for the next phase of regulations would have less than optimal results. For the same reasons that the United States held diesel engines to the same NO_x emission standards as gasoline standards, gasoline and diesel of similar capabilities should be held to the same efficiency and CO_2 standards.

The rationale for fuel neutral standards extends beyond the particular question of gasoline and diesel standards for commercial pickups and vans. Fuel neutral standards are even more critical for the regulatory treatment of vehicles that use alternative fuels, such as natural gas. Incorporating natural gas vehicles within fuel neutral standards provides them the best possible opportunity to effectively compete and contribute toward regulatory compliance due to their low CO_2 emission characteristics. Natural gas-fueled pickups and vans are increasingly showing potential for significant oil displacement, and might also help reduce climate-related emissions if upstream methane emissions can be mitigated appropriately. Using separate standards for natural gas will take away the regulatory inducement to sell natural gas vehicles that have lower carbon emissions than comparable diesel and gasoline vehicles. Placing natural gas vehicles within fuel neutral standards is the most clear-cut way to promote their deployment for their lower-carbon characteristics. In addition, fuel neutrality is important for many of the same reasons in the vocational and engine standards of the medium- and heavy-duty vehicles, where there are similar dynamics at play.

Implementing fuel neutral performance standards is good environmental policy. It is also good industrial policy to promote leading gasoline efficiency in trucks, and it will also better promote low-CO_2 natural gas vehicles. Moving from separate 2018 gasoline and diesel standards to fuel neutral standards for 2025 and beyond would correct the problems identified above that were introduced in the original rulemaking.

Recommendation #3. Investigate and make commercial pickup and van sales, CO_2 emissions, fuel consumption, and attribute data publically available.
Commercial pickup and van sales are apparently anywhere between 600,000 and 1.2 million vehicles per year, depending on the data source. This data uncertainty raises a number of questions. Any systematic trend of pickups and vans upward from the light-duty category to the less stringent heavy-duty category would present a significant erosion of regulatory benefits and would suggest that a leveling of the light- and heavy-duty regulatory stringency is in order. Recent data suggest that sales of heavy-duty pickups and vans are increasing far more rapidly than projected, suggesting that such an upward trend is already occurring. Better public disclosure on market shifts related to this vehicle class is important to assess the effectiveness of the existing rule and to better evaluate what is at stake in the 2020 and beyond rulemaking. This would help increase the public confidence that the regulation is delivering on the expected benefits, as projected at the adoption of the first phase of the standards.

Several important issues for commercial pickups and vans are beyond the scope of this work and warrant future investigation. Foremost among the unresolved, major issues is the question about the regulatory “work factor,” to which the 2014-2018 standards are indexed; availability of data on pickup and van models’ CO_2 emission levels, sales, and related attributes (e.g., torque, payload, towing, drive type) would help in better understanding the market dynamics. Investigation into this foundational element of the standards is critical to understanding whether the standards are subject to sales trends that erode program benefits, but data to analyze such trends are not publically available. Another notable trend that warrants investigation is the extent to which the trends toward new designs of vans (e.g., the Ford Transit, Ram ProMaster, Nissan NV) impact baseline fuel efficiency and technology availability in the commercial van fleet.

Furthermore, study into best practices in consumer fuel efficiency labeling could be helpful in informing if, or how best, to convey efficiency information to pickup and van consumers. For example, it seems conceivable that a relative efficiency scale could easily be created that uses vehicle certification data to provide highly useful information to pickup and van consumers, who otherwise are making entirely uninformed decisions about technology, fuel economy, and fuel savings. In addition, the rationale for fuel neutral standards could be extended to other alternative fuel types but requires further investigation. Incorporating natural gas vehicles within fuel neutral standards would give these vehicles the ability to effectively compete and contribute toward fleet regulatory compliance, whereas isolating them in natural gas-specific standards would not. Finally, improved evaluation of the average travel and payload activity of commercial pickups and vans could also help inform the technology applicability, testing protocols, and cost-benefit analysis for the approaching rulemaking.

The implications of this study go beyond particular questions about the optimal US regulatory design to promote efficiency technology for greater fuel savings among gasoline and diesel trucks. At stake is the larger principle of whether governments around the world are in the business of setting separate environmental standards that are skewed toward preferred vehicle technology types. This is important for gasoline and diesel vehicles, but it is also important for alternative fuels that might eventually be able to unseat the incumbent petroleum fuels. For example, natural gas and electric-drive technologies only get to compete and contribute toward regulatory goals if they are integrated within the same fuel neutral standards as the conventional vehicles. The strongest and most cost-effective long-term policies promote all technologies according to their energy and emissions characteristics, and then let the market do the rest.

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