

The Optimization of the Light-Duty Automotive Fleet for Cost Effective Fuel Efficiency

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ABSTRACT

This paper describes the composition of the light-duty automotive fleet leading to 2020 and how it differs from today's fleet. The most likely scenario for the fleet of 2020 is one where vehicle manufacturers strive to achieve the mandatory regulatory requirements at minimum investment and cost. Simultaneous achievement of multiple regulatory requirements with minimum investment and cost is actually just an optimization problem. What makes this particular optimization especially difficult is that California Air Resources Board (CARB), the National Highway Traffic Security Administration (NHTSA), and potentially the Environmental Protection Agency (EPA) have all chosen different standards and even different metrics that are inextricably linked to fuel efficiency but place different demands on the fleet and even separately on cars and trucks. Many manufacturers have migrated to a global engineering organizational model where product is engineered in one location for all or nearly all global markets. This means that automakers need to include both US and European regulations into product planning decisions. Combine the differing US regulations with the European Union CO₂ standards that are based on weight, and identifying the optimum portfolio for global manufacturers is unequivocally difficult. Therefore, the answer to the question of which combinations of technologies will meet the regulatory requirements, achieve customer expectations, and minimize investment involves a comprehensive accounting of costs and benefits of technologies, potential pace of technology implementation, changing consumer behavior, and global requirements. Such an accounting of the variables are herein explored in Ricardo's Total

Vehicle Fuel Economy (TVFE) systems engineering toolset to determine the most likely outcomes affecting the light duty vehicles in the future.

INTRODUCTION

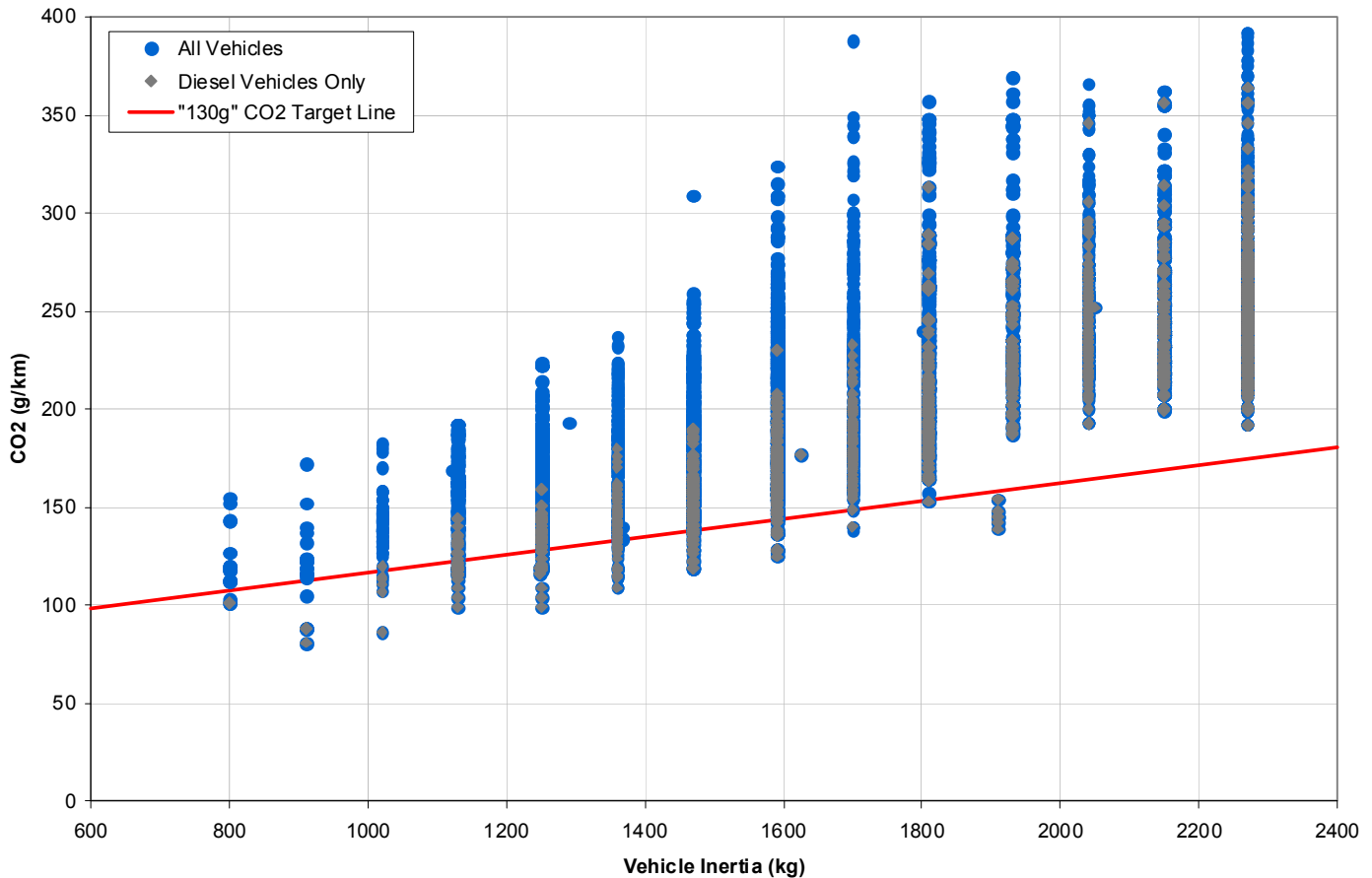
There is a significant global trend of government action to regulate fuel economy and emissions of light-duty vehicles. In the US, Congress mandated fuel efficiency standards in the Energy Independence and Security Act of 2007 (EISA) that require a minimum fleet average of 35 miles per gallon (MPG) fuel economy by 2020. In response, in April, 2008 NHTSA issued a Notice of Proposed Rulemaking (NPRM) for Corporate Average Fuel Economy (CAFE) standards applicable to the 2011-2015 timeframe for light-duty vehicles based on vehicle footprint. Further, CARB, if granted a waiver for California Assembly Bill 1493 (also known as the "Pavley Bill" or AB 1493) that requires specified light duty passenger vehicle green house gas emissions reductions, effectively requires the US fleet average fuel economy to reach 42.5 MPG by 2020. What makes this particular optimization especially difficult is that CARB, NHTSA, and potentially the EPA have all chosen different standards and even different metrics that are all inextricably linked to fuel efficiency but place different demands on the fleet and even separately on cars and trucks.

In Europe, voluntary standards have given way to mandatory CO₂ standards based on vehicle weight and are complemented by parallel taxation incentives. The European Commission has proposed legislation requiring 130g/ km by 2012, which is approximately

equivalent to 45 MPG. Figure 1 shows the disparity between that target and the 2008 fleet, which currently achieves the equivalent of approximately 37 MPG. Unless Manufacturers intend to pay the fines associated

with non-compliance, vehicle in Europe will need to reduce average vehicle CO₂ emissions by approximately 20% between 2008 and 2012.

Figure 1: 2008 European LD Vehicle Fleet Weight vs. CO₂



MEETING THE CHALLENGE

In order to simultaneously meet the global regulatory requirements related to footprint and weight based fuel economy and CO₂ standards, new technologies will be required to be adopted. The reason other variables are excluded from consideration is explained below.

In the US, the 2008 CAFE fuel economy of approximately 26.8 MPG can be improved to reach the 2020-targeted minimum value of 35 MPG through adoption of fuel economy improving technologies, a shift in consumer purchase decisions toward smaller, more fuel efficient vehicles, or both. For the purposes of this study it was assumed that vehicle manufacturers would strive to achieve the applicable regulatory requirements at minimum investment and cost in order to have the highest likelihood of recouping the costs from consumers. There are various ways to decrease the fuel consumed by the light duty fleet – some of which effect fleet-wide CAFE or CO₂ status and others that do not. Factors out of control of a manufacturer or not included in CAFE calculations and therefore not included in this study include the absolute price of fuel, driver behavior, SAE Int. J. Fuels Lubr. | Volume 2 | Issue 1

and the vehicle miles traveled. Factors in control of a manufacturer but not included here are the abilities to trade credits amongst manufacturers or to mix-manage on a portfolio level which permit manufacturers to transfer credits from one compliance category to a non-compliance category.

NHTSA's Notice of Proposed Rulemaking (NPRM) issued in May, 2008 proposes to use vehicle footprint as the attribute by which light-duty vehicle fuel economy standards are established and compliance is evaluated for the 2011-2015 timeframe. Figure 2 shows an example of a footprint based target for the passenger car vehicle class. Because actual production figures by footprint would be required to calculate an exact CAFE target for each manufacturer and because future production figures will invariably be different than current production figures, NHTSA could not set out exact levels of CAFE that each manufacturer must meet in future years. The agency did, however, project what the industry wide level of average fuel economy would be for passenger cars and for light trucks if each manufacturer produced its expected mix of automobiles and just met

its obligations under the NPRM. Figure 3 shows these projected targets on an overall fleet basis and displays the rapid increase in the average rate of improvement required from the fleet. From the NPRM we know that the volume weighted foot print of each manufacturer's existing fleet is used to create a CAFE target per manufacturer. Therefore shifts in consumer behavior do not affect compliance with manufacturer targets as these targets also change with the change in volume weighted foot print. This means that shifts in consumer preferences between large and small vehicles that do affect the federal fleet fuel economy are inconsequential

to a manufacturer's ability to comply with manufacturer vehicle fuel economy standards, assuming the final CAFE rule requires equivalent stringency of improvement for sizes of vehicles. And so, manufacturers must pursue a strategy of increased adoption of fuel economy enhancing technologies for all of its vehicles to comply with federal fuel economy regulations and cannot factor in to compliance strategies changes in consumer behavior. Therefore, the key question for manufacturers is *what combination of technologies should be selected to increase vehicle efficiency in the most cost-effective manner?*

Figure 2: Example Footprint Targets for Passenger Car from NPRM

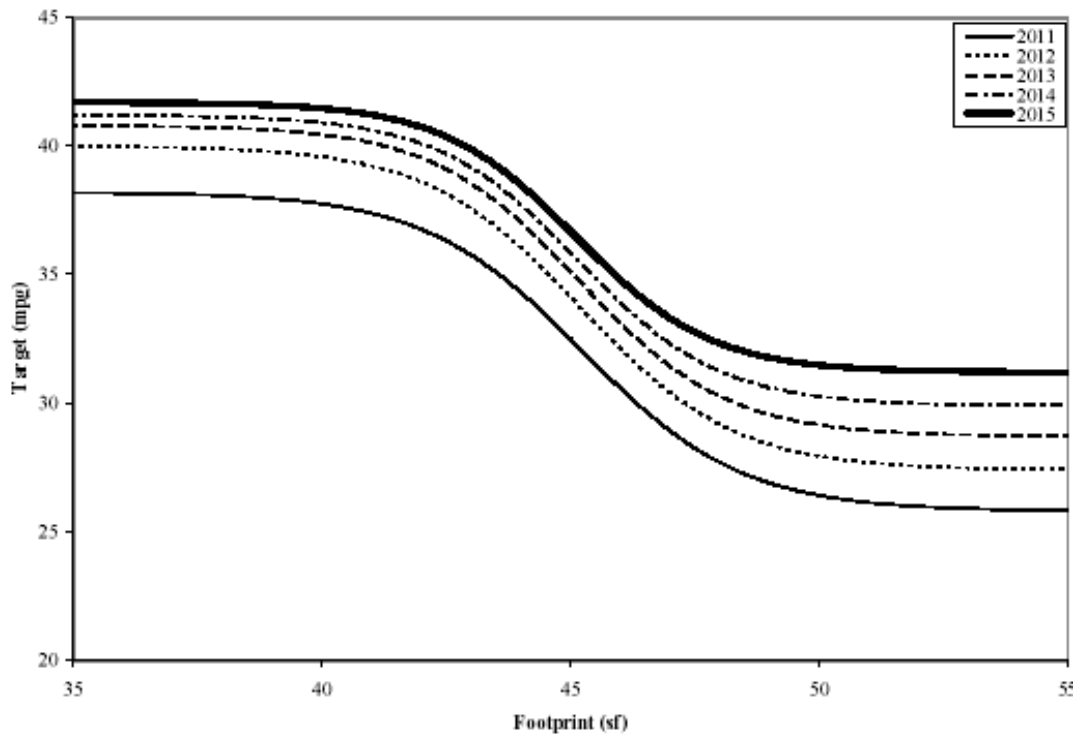


Figure 3: US LD Vehicle Fleet Miles per Gallon Status and Future Targets by Year

