Crucial Greenhouse Gas and Corporate Average Fuel Economy (CAFE) Regulation Differences In the United States

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August 2015

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Acknowledgements

The authors would like to thank the members of the CAR Powertrain Thought Leadership Roundtable for their guidance, input and support with this report. Their willingness to share insights and provide thoughtful feedback was an important contribution, and is greatly appreciated. Our Roundtable member companies are:

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Aisin Technical Center of America

BorgWarner, Inc.

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Delphi Automotive, PLC

Denso International, America

Eaton

Freudenberg-NOK Sealing Technologies

Mitsubishi Electric Automotive America, Inc.

Robert Bosch LLC

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Introduction

An important transition within the automotive industry is underway as fuel economy and CO2 emissions regulations quickly accelerate through the year 2025. The industry will be required by regulation to increase fuel efficiency of the US fleet from 27.5 miles per gallon (MPG) for passenger cars and 23.4 MPG for light duty trucks in 2010 to an estimated 54.5 MPG for all vehicles in model year 2025. The 54.5 MPG number, widely used by the administration, regulators, and media, is an estimate of what the industry must meet in 2025. In reality, it is a representation of a complex set of measurements. The actual fuel economy target required will depend on a variety of factors and will even differ from manufacturer to manufacturer.

Federal regulatory standards for fuel economy and emissions in the United States are administered by two agencies: The U.S. Environmental Protection Agency (EPA) and the National Highway Transportation Safety Administration (NHTSA). While the standards are to a certain extent harmonized, they are not necessarily in complete alignment. This divergence is due to the differing missions of each agency—the EPA focusing on emissions, and NHTSA on fuel economy. Powertrain technology and alternative fuels have a direct impact on fuel economy and emissions—and the overall compliance strategy for a manufacturer. Certain fuels are more likely to reduce greenhouse and smog-forming emissions as well as petroleum use.

Petroleum and GHG Reduction Variances

The general perception is that EPA and NHTSA share a common objective to improve the fuel efficiency of vehicles for sale in the United States; however, the actual goals differ between the agencies. These differences have some effect on the type of technology that may be implemented by the industry to meet those objectives. The primary objective of the Corporate Average Fuel Economy (CAFE) regulations under NHTSA is the reduction of petroleum consumption. As a result, NHTSA provides additional flexibilities for technologies that encourage the reduction of petroleum. Conversely, EPA is focused on the reduction of GHG emissions and provides additional flexibilities for technologies that reduce GHG emissions. This subtle difference between petroleum reduction and GHG reduction has a direct influence on the types of fuels that are most beneficial under the harmonized but separate regulations. The following section describes how the differences between petroleum reduction and GHG reduction influence the use of certain alternative fuels (e.g., natural gas, biodiesel, ethanol, etc.).

By knowing the chemical composition of a fuel, a relationship can be developed to convert fuel economy into GHG emissions, and vice versa. The relationship between fuel economy and GHG is found in the following equation:

Equation 1:

$$CO_2\ per\ mile = \frac{C_f}{FE_f}$$

Where FE_f is the fuel economy expressed in miles per gallon and C_f is a constant based on the fuel used (Table 1). The constant, C_f, is derived from the amount of GHG (or specifically in this case CO_2) emissions

that would be generated by a particular fuel through the combustion process. For gaseous fuels, such as compressed natural gas (CNG), the constant is based on a gasoline gallon-equivalent (GGE) for easier comparison with liquid fuels.[1]

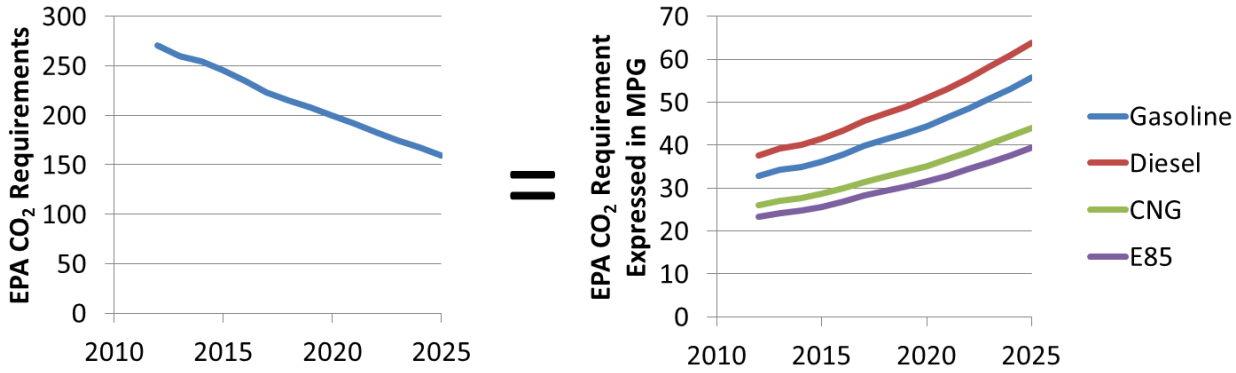
Table 1 Tailpipe CO2 Emissions per Tailpipe[2]

Fuel	C_f (gCO_2 per gallon equivalent)
Gasoline	8,887
Diesel	10,180
E85	6,295
CNG	7,030

Source: United States Environmental Protection Agency

Due to this relationship between fuel economy and GHG, different fuels will need to achieve different levels of fuel economy to meet the equivalent GHG regulation. Fuels with a lower constant will produce less GHG emissions per gallon or GGE of fuel and will therefore be able to meet the GHG standards at a lower fuel economy. For example, using the estimated GHG standard for 2025 of 163 gCO_2 per mile, the equivalent fuel economy based on gasoline is the often quoted 54.5 MPG number; however, when using a fuel other than gasoline the fuel economy equivalent is something other than 54.5 MPG. The estimated GHG standard from 2012 to 2025 and the equivalent required fuel economy for various fuels are shown on Figure 1.

Figure 1: Miles per Gallon Equivalent of Selected Fuels, and CO2 Conversion, 2010-2025



Source: CAR Research

Conversely, CAFE regulations do not make a distinction between fuels and require the same fuel economy standard regardless of the fuel used (however, CAFE does offer flexibilities to encourage alternative fuel use which are discussed below). This exemplifies a seemingly small, but important differentiation between the GHG and CAFE regulations. A diesel vehicle, for example, will perform better against the CAFE standard than it will against the GHG standard. Since automakers must comply with both standards, they must balance how each fuel performs for GHG and fuel economy, which may

[1] Alternative Fuels Data Center, http://www.afdc.energy.gov/fuels/fuel_comparison_chart.pdf
[2] Guidance for Implementing Section 141 of the Energy Independence and Security Act of 2007: Federal Vehicle Fleets and Low Greenhouse Gas-Emitting Vehicles (February, 2010)

limit the applicability of a technology that provides a significant benefit for one standard but not the other.

Petroleum Reduction Credits

While NHTSA does not consider the impact of a particular fuel in terms of its GHG emissions, it does consider the potential of an alternative fuel to reduce the usage of petroleum during combustion. As a result, NHTSA provides additional flexibilities for fuels that displace petroleum during its use. Only a portion of every gallon equivalent of alternative fuel is assumed to be from petroleum sources.[3] Under the CAFE regulations it is assumed that only 15 percent of a dedicated alternative fuel is from petroleum sources. A petroleum reduction credit is applied by taking the fuel economy of an alternative fuel vehicle and dividing in by 0.15. The petroleum reduction credit for dedicated alternative fuel vehicles (equation 2) and flex fuel vehicles (equation 3) for the purposes of CAFE are as follows:

Equation 2: Petroleum Reduction Credit for Alternative Fuel Vehicles

$$FE_{reg} = \frac{FE_{alt\ fuel}}{0.15}$$

Currently the utility factor (F) for use in CAFE calculations for flex fueled vehicles is 0.5. The implication being 50 percent of a flex fueled vehicle operation is done through the use of the flexible fuel. To limit the extent of this flexibility, NHTSA has capped this credit for flex fuel vehicles to assure it does not increase a manufacturer's CAFE excessively. This cap will decrease each year between MY 2015 (1.2 MPG) and MY 2019 (0.2 MPG). Starting MY 2020, for use in CAFE calculations, this utility factor will be based on the utilization of the flexible fuel in the market place—that is real world usage rates. Also starting MY 2020, the CAFE cap for flex fuel vehicles will be lifted.

Equation 3: Petroleum Reduction Credit for Flex Fuel Vehicles

$$FE_{reg} = \frac{1}{\frac{(1-F)}{FE_{gas}} + F\frac{0.15}{FE_{flex\ fuel}}}$$

An E85 flex fuel vehicle operating at 30 MPG on gasoline and 25 MPG on E85 would be treated as achieving 51 MPG (equation 4). The 51 MPG rating of this example may be applied to the fleet CAFE, but is limited to the cap (1.2 MPG in MY 2015) of raising the CAFE.

Equation 4: Petroleum Reduction Credit for Flex Fuel Vehicles—E85 Example

$$FE_{reg} = \frac{1}{\frac{(1-F)}{FE_{gas}} + F\frac{0.15}{FE_{flex\ fuel}}} = \frac{1}{\frac{0.5}{30} + 0.5\frac{0.15}{25}} = 51\ MPG$$

[3] Some alternative fuels include alcohol fuels such as methanol and ethanol, natural gas, liquefied petroleum gas, and hydrogen. The definition of alternative fuels is found in United State Code Title 42 Chapter 134 Subchapter I Section 13211: http://www.gpo.gov/fdsys/pkg/USCODE-2004-title42/html/USCODE-2004-title42-chap134-subchapI-sec13211.htm

For CAFE, a dedicated CNG vehicle operating at 30 miles per gasoline gallon-equivalent is treated as a 200 mile per gallon vehicle (Equation 5). There is no limit to the extent at which this CNG vehicle raises the CAFE for a particular manufacturer.

Equation 5: Petroleum Reduction Credit for Alternative Fuel Vehicles—CNG Example

$$FE_{reg} = \frac{FE_{alt\ fuel}}{0.15} = \frac{30\ MPG}{0.15} = 200\ MPG$$

The EPA has temporarily mirrored the petroleum reduction credit in the GHG standards for flex and alternative fuel vehicles, but the accrual of GHG related petroleum reduction credits will no longer be offered after 2015. Starting with MY 2016, the EPA will only consider the tailpipe GHG emissions of a particular fuel. The equations for GHG performance of alternative fuels starting with MY 2016 are:

Equation 6: GHG Performance of Alternative Fuel Vehicles (Starting in MY 2016)

$$GHG_{reg} = GHG_{alt\ fuel}$$

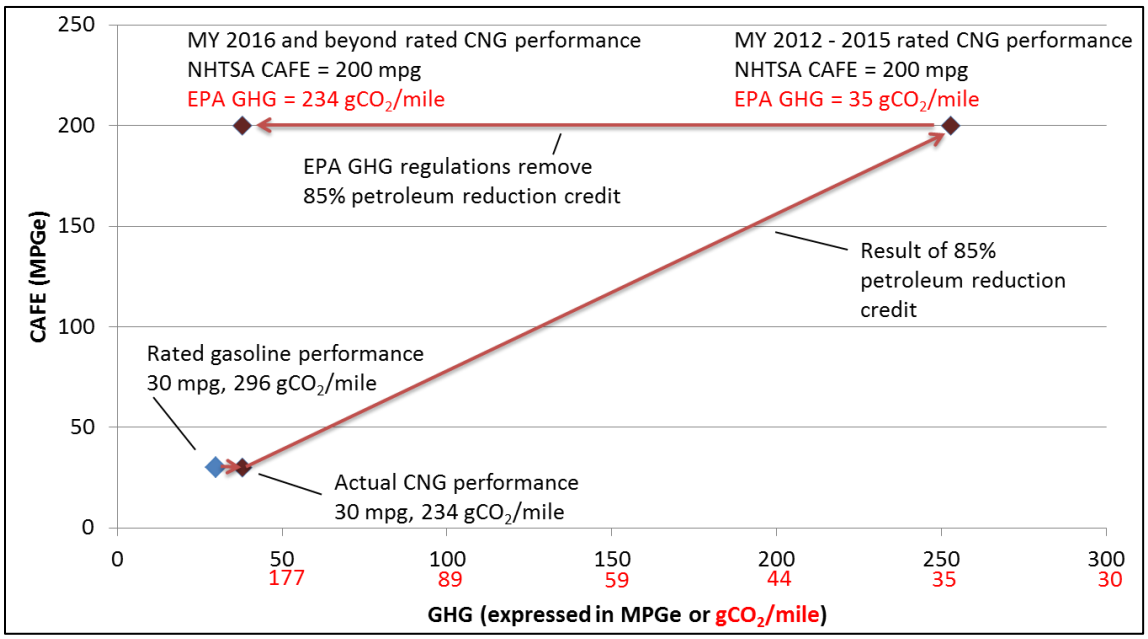
$$GHG_{reg} = (1 - F)GHG_{gas} + F * GHG_{flex\ fuel}$$

The utility factor, F, serves the same purpose as with CAFE; however, the EPA will begin adjusting the factor based on real world fuel use in MY 2016. Currently the factor, F, is set at 0.14 for MY 2016 through 2018.[4] There are no caps associated with flex fuel vehicle in the GHG regulation as there are with the CAFE regulation. Reusing the examples above, the 30 MPG CNG vehicle would have a GHG rating of 234 gCO_2 per mile (38 MPG gasoline-equivalent). This is a much lower incentive than the 200 MPG that vehicle would receive credit for under the CAFE standard.

Figure 2 presents the above data, and illustrates the EPA challenge. The example begins with a gasoline-powered vehicle with a fuel economy of 30 MPG. After conversion to CNG, the vehicle fuel economy is still estimated at 30 MPG but the CO_2 emissions are reduced by approximately 20 percent (from 296 to 234 gCO_2/mile). From 2012 to 2015, an 85 percent petroleum reduction incentive is applied to both the CAFE and GHG ratings. The petroleum reduction incentive results in a rated fuel economy of 200 MPG and GHG rating of 35 gCO_2/mile. However, starting with 2016, the EPA will only recognize CO_2 reductions of CNG resulting in a GHG rating of 234 gCO_2/mile while the rated fuel economy will remain 200 MPG.

[4] EPA E85 Flexible Fuel Vehicle Weighting Factor for Model Year 2016-2018 Vehicles (http://www.epa.gov/otaq/datafiles/cd1418.pdf)

Figure 2: CAFE and GHG Regulatory Value of CNG Vehicles Compared to Gasoline under Current Regulations



Source: CAR Research 2014

Decoupling of Credits

From a regulatory perspective, the credits that are available based on the petroleum reduction benefit of CNG are of far greater significance than those based on fuel chemistry. For model year 2012 to 2015, the EPA has harmonized with NHTSA with regard to 85 percent petroleum reduction to provide lead time to manufacturers as the regulations change from a petroleum reduction focus to a GHG reduction focus. For model year 2016 and beyond, the EPA will no longer credit alternative fuel vehicles for petroleum reduction.[5] With the elimination of petroleum reduction credits for the EPA GHG regulations, there will be a decoupling of the NHTSA CAFE and EPA GHG regulations. Given the importance of meeting EPA GHG regulations, the elimination of petroleum reduction credits is seen as a major inhibitor of the market potential for CNG and other alternative fueled vehicle market potential.

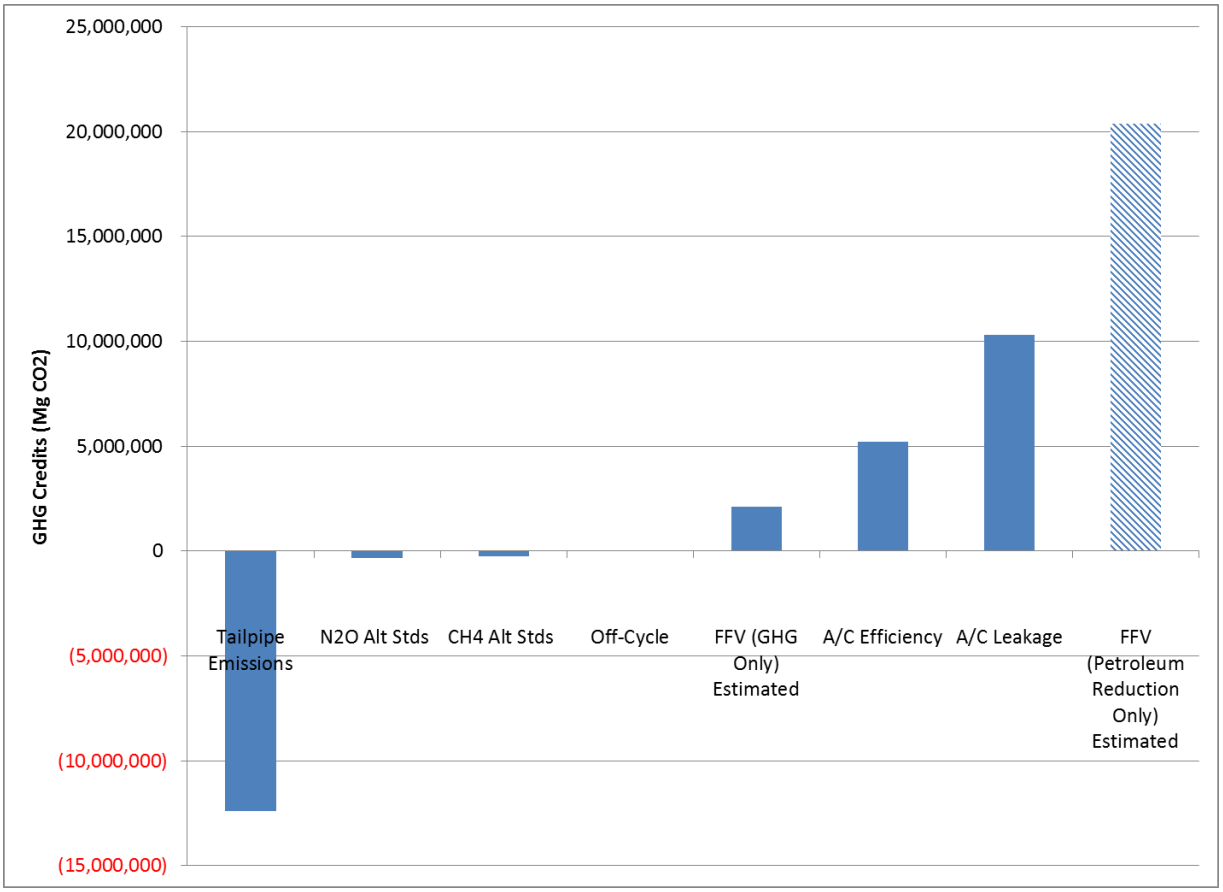
The complex collection of credits and flexibilities comprise a significant portion of the compliance strategy for several manufacturers. In fact, the petroleum reduction credits were the majority of credits earned by the industry in 2012, according to the EPA.[6] Of the 25 million metric ton of GHG credits earned by the industry for MY 2012, 22.5 million were the result of flex fuel vehicles (Figure 3). An

[5] In the MY 2012 – 2016 final rule the EPA states, "CAA section 202(a) does not mandate that EPA treat FFVs in a specific way. Instead EPA is required to exercise its own judgment and determine an appropriate approach that best promotes the goals of this CAA section. Under these circumstances, EPA will treat FFVs for model years 2012–2015 the same as under EPCA, as part of providing sufficient lead time given manufacturers' compliance strategies which rely on the existence of these EPCA statutory credits, as explained above. Starting with model year 2016, as proposed, EPA will no longer allow manufacturers to base FFV emissions on the use of the 0.15 factor credit described above, and on the use of an assumed 50 percent usage of alternative fuel. Instead, EPA believes the appropriate approach is to ensure that FFV emissions are based on demonstrated emissions performance. This will promote the environmental goals of the final program."

[6] EPA MY 2012 Manufacturer Report, U.S. Environmental Protection Agency

estimated 20 million of those FFV credits are the result of petroleum reduction credits and will no longer be available to manufacturers starting in MY 2016 (the diagonally shaded bar in Figure 3). The rest of the FFV credits are the result of reduced GHG emissions of the alternative fuels as explained in the previous section.

Figure 3: GHG Credits by Type, 2012



Source: U.S. Environmental Protection Agency, CAR Research

In addition to the omission of petroleum reduction credits by the EPA, both the EPA and NHTSA are moving toward a utility weighting factor for flex fuel vehicles based on the real world use of flex fuels. This weighting factor would determine the portions of fuel economy or GHG performance that would count towards petroleum and GHG reduction. The following table is a timeline of changes to the petroleum credits that will be available for the CAFE and GHG regulations.

Table 2: Timeline of Changes Petroleum Credits for CAFE and GHG regulations, 2012-2025

		Model Year												
		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Petroleum Reduction	EPA GHG														
- 85% improvement in flex fuel fuel economy	NHTSA CAFE														
Flex Fuel Vehicle Credit Cap	EPA GHG														
- maximum total CAFE credit for flex fuel vehicles	NHTSA CAFE	1.2 mpg				0.8		0.6		0.4		0.2			
50 Percent Flex Fuel Utilization	EPA GHG														
- Assumes vehicles operate on flex fuel 50 percent of the time	NHTSA CAFE														
Real World Flex Fuel Utilization	EPA GHG														
- Weighting of flex fuel use based on real world utilization	NHTSA CAFE														

Source: U.S. Federal Register Vol. 77 Num. 199

Without the benefit of petroleum reduction credits, some manufacturers may shift their strategy from developing and selling vehicles with alternative fuels such as E85 and CNG to other technologies that do receive credits for both the CAFE and GHG regulations. These other credits may come from off-cycle technology, advanced A/C systems and refrigerants, and advanced light duty truck technology (such as hybridization).

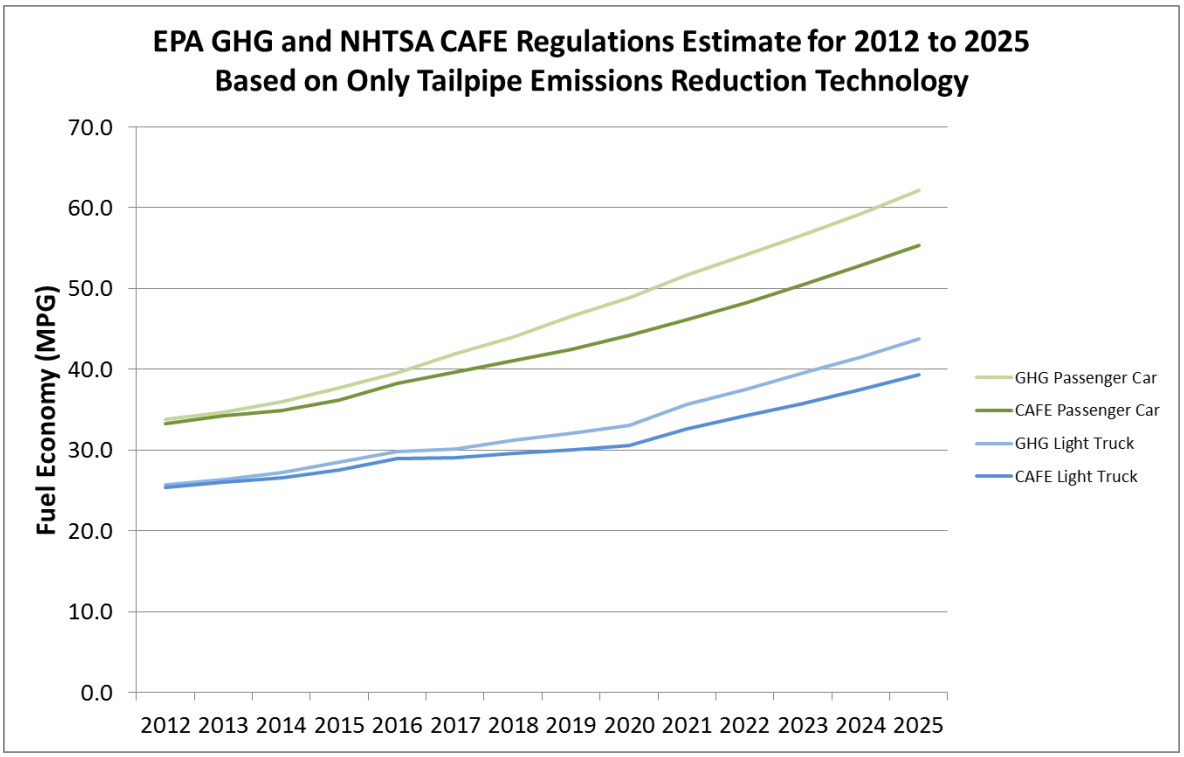
Air Conditioning Refrigerant and Leakage Credits

In addition to tailpipe emissions, the EPA is also able to regulate other vehicular emissions that may pose harm to the environment. As a result, the EPA provides GHG credits for the use of air conditioning (AC) refrigerants with lower global warming potential and technology that reduces the potential for refrigerant leakage throughout the life of the vehicle. NHTSA is not allowed to offer similar credits, as its focus is petroleum reduction not GHG reduction.

To harmonize the EPA GHG and NHTSA CAFE regulations, NHTSA basis their CAFE under the assumption that manufacturers will leverage the available AC refrigerant and leakage credits as a low cost option to meeting the GHG regulations. If manufacturers do fully utilize the available AC refrigerant and leakage credits, the required fuel economy to meet both the GHG and CAFE regulation will be essentially the same. However, if a manufacturer does not fully utilize these credits, the GHG regulation will require a higher fuel economy than CAFE.

Without the use of these AC refrigerant and leakage credits, the automotive industry would need to increase fuel economy by an additional 7 MPG for passenger cars and 4 MPG for light trucks over CAFE to meet the EPA GHG regulations (see Figure 4). It is also worth noting that the oft quoted 54.5 MPG is based on the EPA GHG regulation assuming only tailpipe emission reductions.

Figure 4. Estimated fuel economy required to meet the EPA GHG and NHTSA CAFE regulations assuming only tailpipe emission reductions, MY 2012-2025



Source: U.S. Federal Register Vol. 77 Num. 199

Conclusions

This paper illustrates several differences between regulation for fuel economy and emissions as administered by the EPA (emissions) and NHTSA (fuel economy). While the standards are to a certain extent harmonized currently, they will increasingly decouple over the coming decade because of their respective legislative responsibilities. This decoupling may lead manufacturers to alter their overall compliance strategy in the coming decade. It may also become an important point of consideration during the Mid Term Evaluation and should be monitored closely.