Greenhouse Gas Emission Standards for Light-Duty Vehicles

Manufacturer Performance Report for the 2012 Model Year

United States Environmental Protection Agency

EPA-420-R-14-011 April 2014

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Porsche
Toyota
Honda
Mazda
Ford
Subaru
General Motors
Mitsubishi
Nissan
Volkswagen
BMW
Chrysler
Volvo
Mercedes-Benz
Suzuki
Jaguar
Land Rover
Ferrari
Coda
Tesla
Fisker
Porsche
Toyota
Honda
Mazda
Ford
Subaru
General Motors
Mitsubishi
Nissan
Volkswagen
BMW
Chrysler
Volvo
Mercedes-Benz
Suzuki
Jaguar
Land Rover
Ferrari
Coda
Tesla
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Honda

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NOTICE:

This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.

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Executive Summary

On May 7, 2010, the Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) issued a joint Final Rule to establish a National Program with new standards for light-duty vehicles that reduce greenhouse gas emissions and improve fuel economy.[1] EPA finalized greenhouse gas emissions (GHG) standards under its authority in the Clean Air Act, and NHTSA finalized Corporate Average Fuel Economy (CAFE) standards under the Energy Policy and Conservation Act of 1975, as amended (EPCA). These standards apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles, covering model years 2012 through 2016, and represent the first phase of the EPA and NHTSA joint harmonized National Program. On October 15, 2012, EPA and NHTSA issued a subsequent rulemaking further reducing greenhouse gas emissions and improving the fuel economy of light-duty vehicles for model years 2017–2025, building on the success of the first phase of the joint National Program.[2]

In March 2013, EPA released a report documenting manufacturers' use of the early credit provisions allowed under the GHG standards for the 2009-2011 model years.[3] EPA is releasing this subsequent report as part of our continuing commitment to provide the public with transparent and timely information about manufacturers' compliance with the GHG program. This report summarizes the information presented in the March 2013 report and presents substantial detail regarding the performance of the manufacturers towards meeting GHG standards in the 2012 model year – the first model year of the standards. As was the case with the March 2013 report, we are excluding Hyundai and Kia data because of the ongoing investigation into their testing methods. This report is also a reference for users of the GHG credits data, which we are making available in formats appropriate for importing into spreadsheets or database applications.[4] Similarly, information on the CAFE program can be downloaded from the NHTSA website.[5]

The 2012 model year was the first year of a 14-year program to reduce the greenhouse gas emissions from new light-duty vehicles. Because the program allows credits and deficits to be carried into future years, at the close of the 2012 model year no manufacturer is considered to be out of compliance with the program. We intend to report annually on the status of manufacturers and their compliance with the program.

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[1] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Final Rule, Federal Register 75 (7 May 2010): 25324-25728.

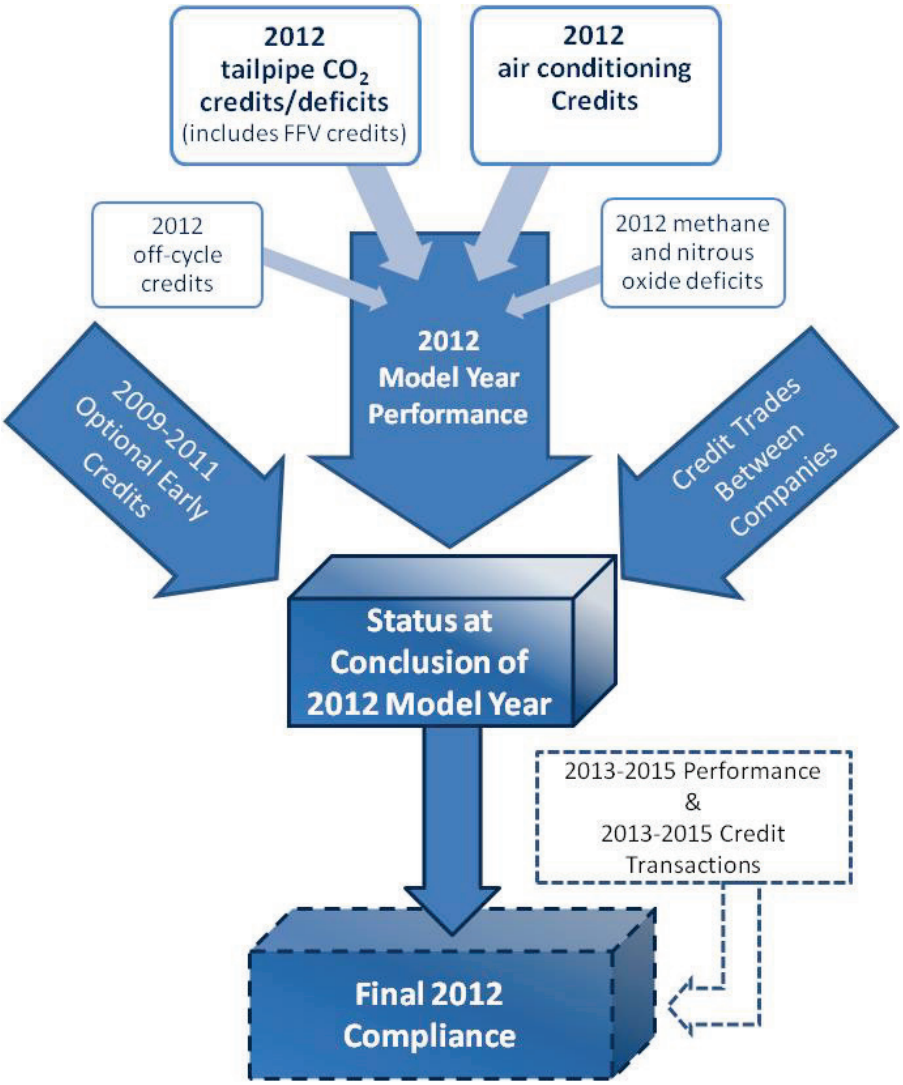
[2] The CO_2 standards for the 2022-2025 model years are subject to future evaluation under 40 CFR 86.1818-12(h), which describes the "mid-term evaluation" process. This mid-term evaluation, which will be completed by April 1, 2018, will include an opportunity for public comment and will be carried out jointly with NHTSA as they are similarly required to evaluate the augural CAFE standards for model years 2022-2025 under their regulations. EPA and NHTSA also expect to involve the California Air Resources Board, recognizing the agency's interest "in maintaining the National Program to address GHG emissions and fuel economy" (see 77 FR 62628, October 15, 2012).

[3] Greenhouse Gas Emission Standards for Light-Duty Automobiles: Status of Early Credit Program for Model Years 2009-2011, Compliance Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, Report No. EPA-420-R-13-005, March 2013.

[4] This report and the data upon which it is based can be found and downloaded at http://www.epa.gov/otaq/regs/ld-hwy/greenhouse/ld-ghg.htm.

[5] http://www.nhtsa.gov/fuel-economy.

Process for Determining a Manufacturer's 2012 Model Year Compliance Status



There are a number of inputs and a multi-year process to determine manufacturer compliance with the light-duty vehicle GHG emission standards. The majority of this report focuses on detailing the 2012 performance of manufacturers, which includes the following:

- CO_2 exhaust emission performance, including credits for flexible fuel vehicles, relative to a fleet average CO_2 standard (resulting in credits or deficits);
- GHG reductions (credits) from improvements to air conditioning systems that reduce refrigerant leakage or improve system efficiency;
- "Off-cycle" CO_2 emission reductions (credits) from technology improvements that can't be sufficiently measured by EPA test procedures; and
- GHG deficits from meeting alternative methane or nitrous oxide standards.

The aggregation of all of these elements represents a manufacturer's 2012 model year performance. But this is only an intermediate step, a single model year snapshot, the results of

which do not define compliance or lack thereof. Once the 2012 model year performance is determined, a manufacturer can apply credits available from prior model years (in the case of the 2012 model year, these are credits from the 2009-2011 optional early credits program). In addition, a manufacturer may purchase credits from another manufacturer. When credits from these two sources are added to credits (or deficits) resulting from 2012 model year performance, the result is the status at the conclusion of the 2012 model year. This status is discussed in the concluding section of this report. Finally, because a 2012 model year deficit can be carried forward into the 2015 model year, compliance with the 2012 model year standards can't be fully assessed until the end of the 2015 model year. Thus compliance with the 2012 model year may depend on performance in each of the 2013-2015 model years as well as on credit purchases made in those model years.

2012 Model Year Performance – Does Not Include Impact of Credit Trades or Credit Transfers from Prior Model Years

Manufacturer	2012 Total Vehicle Production	Net 2012 Credits (Mg)	Grams/Mile Equivalent
Tesla	2,952	178,517	309.7
Coda	115	5,524	246.0
Fisker	1,415	46,694	169.0
Porsche*	29,873	198,348	31.8
Toyota	2,020,248	13,163,009	31.6
Honda	1,540,579	7,851,251	24.9
Mazda	279,004	734,887	13.0
Ford	1,754,323	4,333,951	11.9
Subaru	270,012	543,316	9.4
General Motors	2,364,374	2,872,354	5.9
Mitsubishi	64,467	57,837	4.5
Nissan	1,228,164	(729,937)	(2.9)
Volkswagen	565,572	(502,495)	(4.5)
BMW	257,010	(291,272)	(5.6)
Chrysler	1,533,883	(1,892,184)	(5.7)
Volvo	71,807	(175,195)	(12.0)
Mercedes-Benz*	255,405	(748,723)	(14.3)
Suzuki	31,263	(127,699)	(20.3)
Jaguar Land Rover*	54,561	(424,032)	(35.5)
Ferrari*	1,510	(40,983)	(139.0)
Total	**12,326,537**	**25,053,168**	**9.8**

* These companies are using a temporary program that allows all or part of their fleet to be subject to less stringent standards. See Section 3.1.2.

Manufacturers cumulatively generated almost 39 million Megagrams (metric tons, or Mg) of GHG credits in the 2012 model year, as well as almost 14 million Mg of deficits, yielding a net

positive total for the model year of about 25 million Mg of GHG credits, as shown above.[6] On a gram per mile basis, this quantity of credits represents a net industry over-compliance with the 2012 model year CO_2 standards of about 10 grams/mile. This industry-wide over-compliance means that consumers bought vehicles with lower greenhouse gas emissions than the 2012 model year standards required.

In this first year a credit trading market emerged within the program. Six manufacturers participated in credit transactions as buyers or sellers of credits. This is the first time in an EPA light-duty vehicle emissions standards program that credit trading activity has occurred on such a scale, and it is clear that buying credits may be an important way for some manufacturers to bring their fleet into compliance and an incentive for other manufacturers to bring lower GHG vehicles to market early. Credit trading activity is detailed in this report.

Manufacturers widely utilized the optional provisions in the program that allow them to generate CO_2 credits. This is especially true of the optional flexible fuel vehicle (FFV) and air conditioning (A/C) credits, which EPA anticipated would be widely used in the early years of the program.[7] Only one manufacturer reported off-cycle credits (which had been previously approved by EPA, as required) but the volume of these credits is less than 0.03 percent of the total net credit volume.

In the rulemaking for the 2012-2016 model years, we projected a fleet-wide standard of 295 grams/mile and that the industry as a whole would just meet that level (including the use of air conditioning and FFV credits).[8] In fact, the fleet-wide 2012 model year standard (based on sales and footprint values for individual models) was 296 grams/mile, or 1 gram/mile higher than what we predicted. However, the actual performance for the 2012 model year was 286 grams/mile, or 9 grams/mile better than our rulemaking projection.[9] The 2012 standard also represents a significant level of greenhouse gas reductions relative to the performance of manufacturers in the 2011 model year. Overall, the industry lowered tailpipe GHG emissions in model year 2012 relative to 2011 by about 19 grams/mile.[10]

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[6] Because of the division between cars and trucks, the total credits and total deficits cannot be determined from this table, which shows only the net credits by manufacturer. Total credits and deficits are described in Section 3, Tables 3-1 and 3-2.

[7] Credits for flexible fuel vehicles are similar to those in the CAFE program, but are only applicable through the 2015 model year. See Section 4.1.3 for more information.

[8] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Final Rule, Federal Register 75 (7 May 2010): 25324-25728. See Table I.B.2-4, page 25331.

[9] For the purpose of making an appropriate comparison to the rulemaking values, the fleet-wide values cited in this paragraph include Hyundai and Kia data, using estimates for some vehicles subject to the ongoing EPA enforcement action. Final model year 2011-2013 values for Hyundai and Kia have not been determined.

[10] "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2013," U.S. EPA-420-R-13-011, Office of Transportation and Air Quality, December 2013 (Table 4.5, p. 38). Because this is the first year of the GHG program, there is no national data from the 2011 model year for comparison, thus in this first year we are referencing EPA's "Trends" report for a year-to-year comparison. While the Trends report does not provide formal compliance data, Table 4.5 of the Trends report shows that unadjusted, industry-wide (including Hyundai and Kia) CO_2 emissions (not reflecting any credits) were 19 grams/mile lower in model year 2012 relative to model year 2011. Part of this reduction reflects a higher car share of the market in 2012; unadjusted car fleet CO_2 emissions dropped by 17 grams/mile and unadjusted truck fleet CO_2 emissions decreased by four grams/mile. In subsequent years we will be able to compare year-to-year data from EPA's GHG program.

Looking at the 2012 model year performance only (i.e., what manufacturers did with 2012 models, as represented by the center top arrow in the figure above), half the manufacturers had a net deficit. However, the early optional credits from the 2009-2011 model years and credit purchases enabled all but one manufacturer to offset 2012 model year deficits and have credits remaining to carry forward to use in a future model year.

After accounting for the transfer of credits from the early credit program (2009-2011 model years), and for credits from optional credit provisions and credit transactions with other manufacturers, all but one manufacturer (Jaguar Land Rover) finished the 2012 model year with credits remaining to carry over to use in the 2013 or later model years. The table below shows the compliance status of each manufacturer at the conclusion of the 2012 model year.

Status of Manufacturers at the Conclusion of the 2012 Model Year – Includes the Impact of Credit Trades and Credit Transfers from Prior Model Years

Manufacturer	Credits from 2009-2011 Model Years (Mg)	Total Credits from 2012 Model Year (Mg)*	Net Credits Carried Forward to 2013 Model Year (Mg)†
Toyota	80,266,189	13,163,009	93,429,198
Honda	35,425,108	7,851,251	43,276,359
General Motors	24,564,829	2,872,354	27,437,183
Ford	15,296,436	4,333,951	19,630,387
Nissan	17,631,200	(979,937)	16,651,263
Chrysler	9,610,207	(1,892,184)	7,718,023
Subaru	5,755,171	543,316	6,298,487
Mazda	5,482,642	734,887	6,217,529
Volkswagen	6,441,405	(502,495)	5,938,910
Mitsubishi	1,449,336	57,837	1,507,173
Suzuki	876,650	(127,699)	748,951
BMW	884,903	(291,272)	593,631
Volvo	740,358	(175,195)	565,163
Porsche	-	198,348	198,348
Mercedes-Benz	428,044	(320,782)	107,262
Fisker	-	46,694	46,694
Ferrari	90,000	(40,983)	49,017
Coda	-	5,524	5,524
Tesla‡	-	576	576
Jaguar Land Rover	-	(424,032)	(424,032)
Total	**204,942,478**	**25,053,168**	**229,995,646**

* Credits include all those available and used by the manufacturer, including credits from flexible fuel vehicles, air conditioning systems, off-cycle technologies, and deficits from CH_4 and N_2O standards.

† Includes the impact of credit trades with other manufacturers, if any.

‡ Tesla generated credits in the 2010-2012 model years, but sold all of them. They also sold most of their 2012 model year credits. See Sections 2 and 3.1.1.

1 Introduction

1.1 Why are we releasing this information?

We are releasing this report as part of our continuing commitment to provide the public with transparent and timely information about manufacturers' compliance with the GHG program. Previously, in March of 2013 we released a report documenting manufacturers' use of the early credit provisions allowed under the light-duty vehicle GHG program.[11] In the two regulatory actions that established the greenhouse gas emissions standards for light-duty vehicles, EPA and NHTSA committed to making certain information public regarding the compliance of automobile manufacturers with the CO_2 and fuel economy standards while safeguarding confidential business information, as required by regulation.[12] [13]

When EPA and NHTSA issued the proposed rule for the 2012-2016 model year CO_2 and fuel economy standards, the proposal received considerable comment about the need for transparency regarding implementation of the program, and specifically, regarding compliance determinations.[14] Many comments emphasized the importance of making greenhouse gas compliance information publicly available to ensure such transparency. This was also the case with the proposal for 2017-2025 model year greenhouse gas standards, in which we reiterated our commitment to the principle of transparency and to disseminating as much information as we are reasonably, practically, and legally able to provide.[15] In response to the comments we noted that our public release of data could include "…GHG performance and compliance trends information, such as annual status of credit balances or debits, use of various credit programs, attained fleet average emission levels compared with standards, and final compliance status for a model year after credit reconciliation occurs" and that we would "…reassess data release needs and opportunities once the program is underway."[16]

We also committed to further expanding the information we release regarding GHG program compliance, noting in the preamble to the model year 2017-2025 final rule that "…EPA intends to publish the applicable fleet average standards (for cars and for trucks) and the actual fleet performance for each manufacturer, and the resulting credits or debits." Further, we stated that we anticipate publishing "…the amount of credits generated by each manufacturer (separately for each of the car and truck fleets) under the optional credit programs, and the associated volumes of vehicles to which those credits apply." We also suggested that we would likely publish credit transactions, as well as the overall credit or debit balance for each manufacturer

[11] Greenhouse Gas Emission Standards for Light-Duty Automobiles: Status of Early Credit Program for Model Years 2009-2011, Compliance Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, Report No. EPA-420-R-13-005, March 2013.
[12] See 40 CFR Part 2, Subpart B, Confidentiality of Business Information.
[13] A comprehensive description of the EPA GHG program is beyond the scope of this document, thus readers should consult the regulatory announcements and associated technical documents for a detailed description of the program. See http://www.epa.gov/otaq/climate/regs-light-duty.htm.
[14] Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Proposed Rule, Federal Register 74 (28 September 2009): 49454-49789.
[15] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, Final Rule, Federal Register 77 (15 October 2012): 62889.
[16] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Final Rule, Federal Register 75 (7 May 2010): 25469.

after taking into account the credit and debit carry-forward provisions and any credit transactions.

In addition to this report, we already release a considerable amount of information regarding fuel economy, emissions, and vehicle characteristics for each vehicle model. For example, starting with the 2013 model year, the downloadable data available at www.fueleconomy.gov includes CO_2 emission values for each vehicle model. In addition, we release actual vehicle emission test results at www.epa.gov/otaq/tcldata.htm.

1.2 What new data are we publishing?

The EPA GHG program requires compliance with progressively more stringent GHG standards for the 2012 through 2025 model years. The program includes certain flexibilities, several of which were designed to provide sufficient lead time for manufacturers to make technological improvements and to reduce the overall cost of the program, without compromising overall environmental objectives. The conclusion of the 2012 model year represents the close of the first year in which the standards applied, and thus it is the first year in which data is available from all manufacturers producing light-duty vehicles for U.S. sale (the early credit provisions were optional and, while used by a majority of manufacturers, were not universally used, as documented in EPA's March of 2013 report).[17]

The manufacturer-reported data which forms the basis for this report was required to be submitted to EPA by the end of March of 2013.[18] A number of manufacturers requested and were granted extensions of the deadline of 30-60 days. The data reported by each manufacturer includes the calculated manufacturer-specific footprint-based CO_2 standard for each vehicle category (car and truck), the actual fleet-average performance for each vehicle category (which includes flexible-fuel vehicle credits), the quantity of optional credits (e.g., based on air conditioning or off-cycle improvements), credit transfers within a manufacturer between car and truck fleets, or credit trades between manufacturers, and all the data necessary to calculate these reported values.

This report first summarizes the credits generated under the early credit provisions (see EPA's March 2013 report for additional detail regarding the early credits), and then summarizes the data reported by manufacturers for the 2012 model year in a variety of ways. This includes separately detailing manufacturers' use of the flexibilities included in the program (e.g., credits for air conditioning improvements or production of flexible-fuel vehicles), as well as the credit transactions between manufacturers.

Vehicle and fleet average compliance for EPA's GHG program is based on a combination of CO_2, hydrocarbons, and carbon-monoxide emissions (i.e., the carbon-containing exhaust constituents). This is consistent with the carbon balance methodology used to determine fuel consumption for the vehicle labeling and CAFE programs. The regulations account for these

[17] Greenhouse Gas Emission Standards for Light-Duty Automobiles: Status of Early Credit Program for Model Years 2009-2011, Compliance Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, Report No. EPA-420-R-13-005, March 2013.
[18] See 40 CFR 600.512-12.

total carbon emissions appropriately and refer to the sum of these emissions as the "carbon-related exhaust emissions," or "CREE." The carbon-containing emissions are combined on a CO_2-equivalent basis to determine the CREE value, i.e., adjusting for the relative global warming potential of the specific emission constituent. Although the regulatory text uses the more accurate term "CREE" to represent the CO_2-equivalent sum of carbon emissions, the term CO_2 is used as shorthand throughout this report as a more familiar term for most readers.

The CO_2 standards in EPA's GHG program and the related compliance values in this report differ from the CO_2 values reported in EPA's "Trends" report or on new vehicle fuel economy labels.[19] The Trends report presents CO_2 and fuel economy values that are based on EPA's label methodology, which is designed to provide EPA's best estimate of the fuel economy and GHG emissions that an average driver will achieve in actual real-world driving. EPA's CO_2 standards, like the CAFE standards, are not adjusted to reflect real world driving. Instead, the GHG standards and compliance values are based on the results achieved on EPA's city and highway tests, weighted 55 and 45 percent, respectively. Results from these two tests are commonly referred to as the "2-cycle" test procedures, in that they are based on weighted results from two driving cycles. Adjusted CO_2 values that appear in the Trends report and on the EPA fuel economy window stickers will be about 25 percent higher than those in this report, and are based on what is frequently referred to as the "5-cycle" test procedures, because the final results are based on five different test procedures. The 5-cycle procedures include tests that capture the impacts of aggressive driving, cold temperatures, and hot temperatures with air conditioning operating, among other factors. None of these factors are reflected in the 2-cycle tests used to determine compliance with CAFE and GHG standards.

Credits are expressed throughout this report in units of metric tons, also known as Megagrams (Mg). However, in order to present the impact of these credits in terms that might be more understandable to some readers, in a number of places we have calculated and presented a gram per mile equivalent value. Where such a value in a table applies to a

How We Determine a Grams/Mile Equivalent from Megagrams (Metric Tons) of Credits/Deficits

The Megagrams (Mg) of credits or deficits are determined from a value expressed in grams/mile. For example, fleet average credits/deficits are based on the difference between the fleet standard and the fleet average performance, each of which is expressed in grams/mile. The general form of the equation is:

Credits[Mg] = (CO_2 x VMT x Production) / 1,000,000

CO_2 represents the credits in grams per mile. VMT is the total lifetime miles, which we specified in the regulations as 195,264 miles for cars and 225,865 for trucks. Production represents the production volume to which the CO_2 credit applies.

The CO_2 equivalent of a credit value expressed in Mg is derived by reversing the equation as follows:

CO_2[grams/mile] = (Credits[Mg] x 1,000,000) / (VMT x Production)

When using this equation to calculate CO_2 grams/mile for aggregate car and truck credits, we use a VMT value a weighted average of the VMT car and truck value. For example, for the entire 2012 model year fleet covered by this report, the weighted VMT is 206,916 miles. The weighting is by the proportion of cars or trucks relative to the total fleet. The weighting might be manufacturer-specific or for the entirety of the 2012 fleet, depending on the data presented in each table.

[19] "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2013," U.S. EPA-420-R-13-011, Office of Transportation and Air Quality, December 2013. See http://epa.gov/otaq/fetrends.htm.

specific manufacturer, the gram per mile value represents the impact of credits on the fleet of that specific manufacturer, whereas the Total or Summary rows of tables display the gram per mile impact of the total credits across the entire 2012 model year fleet of cars and trucks, whichever may be applicable. Finally, this report does not attempt to summarize or explain all of the elements or details of EPA's GHG program. Readers should consult EPA's final regulations and supporting documents for additional information.[20]

1.3 How can CO_2 emissions credits be used?

The ability to earn and bank credits, including early credits, is a fundamental aspect of the program design intended to give manufacturers flexibility in meeting the 2012-2016 model year standards, as well as to aid in the transition to the progressively more stringent standards in the 2017-2025 model years. Credits represent surplus emission reductions that manufacturers achieve beyond those required by regulation under EPA's program. Credit banking, as well as emissions averaging and credit trading (collectively termed Averaging, Banking, and Trading, or "ABT") have been an important part of many mobile source programs under the Clean Air Act. These programs help manufacturers in planning and implementing the orderly phase-in of emissions control technology in their production, consistent with their typical redesign schedules. These provisions are an integral part of the standard-setting itself, and not just an add-on to help reduce costs. In many cases, ABT programs address issues of cost or technical feasibility which might otherwise arise, allowing EPA to set a standard that is more stringent than could be achieved without the flexibility provided by ABT programs. We believe that the net effect of the ABT provisions allows additional flexibility, encourages earlier introduction of emission reduction technologies than might otherwise occur, and does so without reducing the overall effectiveness of the program.

Credits (or deficits) are calculated separately for cars and trucks. If a manufacturer has a net deficit in either the car or truck category, existing credits must be applied towards that deficit. Although a deficit may be carried forward up to three years, under no circumstances is a manufacturer allowed to carry forward a deficit if they have credits available with which to offset the deficit. If credits remain after addressing any deficits, those credits may be "banked" for use in a future year, or sold or otherwise traded to another manufacturer. Credits earned in the 2010 through 2016 model years may be carried forward and used through the 2021 model year. Credits from the 2009 model year and 2017 and later model years may only be carried forward for five years. Thus, any early credits from the 2009 model year still held by a manufacturer after the 2014 model year will expire and be forfeited. In addition, credits from the 2009 model year may only be used within a manufacturer's fleet, and may not be traded to another manufacturer.[21]

[20] All of the background documents for EPA's GHG regulations are available on EPA's website at http://www.epa.gov/otaq/climate/regs-light-duty.htm.

[21] These restrictions for the 2009 model year were established based on concerns that such credits might provide a "windfall" since the California light truck standards from which early credits could be generated are less stringent than the comparable CAFE standards in effect for that model year.

1.4 Which manufacturers and vehicles are included in this report?

The vast majority of manufacturers producing cars and light trucks for U.S. sale are covered by EPA's GHG program and are included in this report. However, there are some exceptions, as explained below.

1.4.1 Small Businesses

Small businesses are exempt from EPA's GHG standards given that these businesses would face unique challenges in meeting EPA's GHG standards. However, the program allows small businesses to waive their exemption and voluntarily comply with the GHG standards. For the purpose of this exemption, a small business is defined using the criteria of the Small Business Administration (SBA). For vehicle manufacturers, SBA's definition of a small business is any firm with less than 1,000 employees. These businesses account for less than 0.1 percent of the total car and light truck sales in the U.S., thus this exemption has a negligible impact on overall GHG reductions.

1.4.2 Small Volume Manufacturers

Similar to small businesses, some very small volume manufacturers (i.e., manufacturers with limited product lines and production volumes that do not meet the SBA definition of a small business) would likely find the GHG standards to be extremely challenging and potentially infeasible. Given the unique feasibility issues faced by these manufacturers, EPA deferred establishing CO_2 standards for model years 2012-2016 for manufacturers with annual U.S. sales of less than 5,000 vehicles. This deferment is a conditional exemption for these manufacturers for which EPA approval must be requested and granted, not a blanket automatic exemption.[22]

As part of a request for a conditional exemption, which must be done for each model year, eligible manufacturers must demonstrate good faith efforts to attempt to secure GHG credits to the extent credits are reasonably available from other manufacturers. Credits, if available, would be used to offset the difference between a company's baseline emissions and what their obligations would be under the GHG footprint-based standards. Three manufacturers – Aston Martin, Lotus, and McLaren – requested and received a conditional exemption for the 2012 model year. Because the 2012 model year is the first model year of the program, and because companies seeking conditional exemptions were required to submit their requests to EPA prior to the start of the 2012 model year, it is not surprising that a credit market had not yet developed, despite inquiries made by these three companies of manufacturers that were holding credits. The only manufacturers with any credits at the time were those with optional early credits, and most were likely awaiting the conclusion of the 2012 model year to better evaluate their ability to sell credits. Since then, however, it has become clear that some manufacturers are willing to sell credits, and we have seen a number of credit transactions take place, as described in Section 4 of this report. As a consequence, EPA expects small volume manufacturers may be able to purchase credits and use them to comply with the standards in the 2013 and later model years. However,

[22] The deferment applies only to the fleet average CO_2 standards; these manufacturers are required to meet the applicable nitrous oxide (N_2O) and methane (CH_4) emission standards.

because of their conditionally exempt status for the 2012 model year, these manufacturers are not included in this report.[23]

1.4.3 Operationally Independent Manufacturers

Some manufacturers, even though they may be wholly or largely owned by another manufacturer, consider themselves to be "operationally independent" from the company that owns them. EPA's GHG program contains provisions that allow these manufacturers to seek separate and independent treatment under the GHG standards, rather than be considered as part of their parent company. Manufacturers wishing to obtain operationally independent status are required to submit very detailed information to EPA regarding their business structure, financial operations, manufacturing operations, and management structure. The information in an application for operationally independent status must also be verified by an independent third party qualified to make such evaluations. Ferrari, which is owned by Fiat, petitioned EPA for operationally independent status, and EPA granted this status to Ferrari starting with the 2012 model year. As an operationally independent manufacturer with a low U.S. sales volume (1,510 2012 model year cars), Ferrari has the same options as the three small volume manufacturers discussed above, and could petition for a conditional exemption. Ferrari was successful in purchasing a sufficient volume of credits from other manufacturers to offset their 2012 model year deficit, as described Section 4.

1.4.4 Hyundai and Kia

On November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy label estimates for many vehicle models as the result of an EPA investigation of test data. Hyundai and Kia submitted corrected fuel economy and CO_2 emissions data to EPA for the 2011-2013 model years and re-labeled many of their model year 2012 and 2013 vehicle models on the market. For the changes in fuel economy label values for individual vehicles, see http://www.epa.gov/fueleconomy/labelchange.htm. Since EPA's investigation into Hyundai and Kia data is continuing, Hyundai and Kia-specific values are excluded from the tables in this report. These companies have submitted 2012 model year reports, as required, but because of the possibility that the outcome of EPA's investigation could impact the credits accrued by these companies, the credit values and fleet performance of these companies are not being reported. These companies will appear in future reports after the conclusion of EPA's investigation.

1.4.5 Aggregation of Manufacturers

We refer throughout this report to the names of manufacturers at the highest aggregated level, and it may not necessarily be readily apparent who owns who and which brands or manufacturers are included in the results of a given manufacturer. Table 1.4.5-1 shows how manufacturers are aggregated based on the ownership relationships and vehicle partnerships in the 2012 model year.

[23] Conditional exemptions are available only through the 2016 model year, after which manufacturers must comply with the GHG program standards or petition EPA for alternative manufacturer-specific GHG standards. The three manufacturers noted here have already submitted applications requesting alternative standards, and EPA is in the process of reviewing those applications.

Table 1.4.5-1. Aggregation of Manufacturers in the 2012 Model Year

Manufacturer	Manufacturers and Brands Included
BMW	BMW, Mini, Rolls-Royce
Chrysler	Chrysler, Dodge, Fiat, Jeep, Maserati, Ram, VW Routan minivan
Ford	Ford, Lincoln
General Motors	Buick, Cadillac, Chevrolet, GMC, Saab 9-4x
Honda	Acura, Honda
Mercedes-Benz	Maybach, Mercedes-Benz, Smart
Toyota	Lexus, Scion Toyota
Volkswagen[24]	Audi, Bentley, Bugatti, Lamborghini, Volkswagen

[24] In 2009 Volkswagen acquired 49.9 percent of Porsche, then in 2012 purchased the remaining 51.1 percent, resulting in Volkswagen's full ownership of Porsche. EPA regulations allow for a reasonable transition period in the case of mergers such as this, requiring that Volkswagen AG (including Porsche) meet the GHG standards as a single entity "beginning with the model year that is numerically two years greater than the calendar year in which the merger/acquisitions(s) took place." This means that Porsche will be considered a separate entity under the GHG program for the 2012 and 2013 model years, and in 2014 will be considered part of Volkswagen AG.

2 Optional Early GHG Credits from 2009-2011 Model Years

One of flexibilities in the GHG program is an optional program that allowed manufacturers with superior greenhouse gas emission reduction performance to generate credits in the 2009-2011 model years, prior to the 2012 model year (the "early credits program"). Because this was an optional program, without any compliance implications in these early model years, only those manufacturers who achieved emissions performance beyond that required by existing California or CAFE standards chose to provide data; thus the data does not include information for all manufacturers.

Early credits were earned through fleet average CO_2 reductions, improvements to air conditioning systems that reduce refrigerant leakage or improve system efficiency, off-cycle credits for the implementation of technologies that reduce CO_2 emissions over driving conditions not captured by the "2-cycle" test procedures, and introduction of advanced technology vehicles (i.e., electric, fuel cell, and plug-in hybrid electric vehicles). The optional early credits program allowed manufacturers to select from four pathways that provided opportunities for early credit generation through over-compliance with a fleet average CO_2 level specified by EPA in the regulations. Manufacturers wishing to earn early credits selected one of these four pathways, and the selected pathway was followed for the three model years of 2009-2011. Since EPA's GHG standards did not begin until model year 2012, EPA established fleet average thresholds below which manufacturers were able to generate early fleet average credits. For two of the pathways, the emission levels below which credits were available were equivalent to the GHG standards established by California prior to the adoption of the EPA GHG program. Two additional pathways included credits based on over-compliance with CO_2 levels equivalent to the CAFE standards in states that did not adopt the California GHG standards. In March of 2013, EPA released a report documenting manufacturers' use of the early credit provisions allowed under the GHG program (the "early credits report").[25]

Table 2-1 summarizes the credits (or deficits) reported by manufacturers in each of the three model years for each participating manufacturer and shows the total net early credits for each manufacturer. The early credits program required that participating manufacturers determine fleet average credits for each of the three model years under their selected pathway, and that they carry forward their net credits from the three early years to apply to compliance with EPA's GHG standards. Thus, even manufacturers with a deficit in one or more of the early model years, (i.e., their fleet average performance was worse than the applicable emissions threshold under the selected pathway) could benefit from the early credits program if their net credits over the three years was a positive value. Other than Hyundai and Kia, both of which generated early credits but which are excluded from this report, manufacturers not listed in Table 2-1 chose not to participate in the early credits program. Additionally, this table is intended to show the credits reported by manufacturers in these years and does not include the impacts of any credit banking or trading on credit balances. In particular, the sale of some early credits by some manufacturers, as discussed later in this report, while not shown in Table 2-1, will affect the available credit balances of the manufacturers involved in such transactions, as will the use of early credits to

[25] Greenhouse Gas Emission Standards for Light-Duty Automobiles: Status of Early Credit Program for Model Years 2009-2011, Compliance Division, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, Report No. EPA-420-R-13-005, March 2013.

offset 2012 model year deficits. Table 2-2 shows the total early credits reported by each participating manufacturer, broken down by the type of credit reported. Note that the early credits program did not include credits for flexible-fuel vehicles, whereas in the 2012 model year the fleet average credit category does include these credits.

Table 2-1. Early Credits, by Manufacturer and Model Year (Mg)

Manufacturer	2009	2010	2011	Total
BMW	409,854	280,450	194,599	884,903
Chrysler	5,926,979	4,833,763	(1,650,535)	9,110,207
Ford	8,252,113	7,093,702	(49,379)	15,296,436
General Motors	13,009,374	11,073,134	482,321	24,564,829
Honda	14,073,890	14,070,290	7,370,928	35,515,108
Mazda	1,405,721	3,201,708	875,213	5,482,642
Mercedes-Benz	96,467	124,120	157,685	378,272
Mitsubishi	625,166	521,776	302,394	1,449,336
Nissan	10,496,712	5,781,739	1,852,749	18,131,200
Subaru	1,620,769	2,225,296	1,909,106	5,755,171
Suzuki	448,408	329,382	98,860	876,650
Tesla	-	35,580	14,192	49,772
Toyota	31,325,738	34,457,797	14,482,654	80,266,189
Volkswagen	2,243,205	2,811,663	1,386,537	6,441,405
Volvo	204,460	359,436	176,462	740,358
Total	**90,138,856**	**87,199,836**	**27,603,786**	**204,942,478**

Notes:
(1) The early credits program did not allow credits from flexible fuel vehicles, thus no such credits are reflected in this table.
(2) Some of the values in this table will not match those reported in EPA's March 2013 report because of errors that were discovered and corrected after the March 2013 report was released.

Table 2-2. Total Reported Early Credits, By Credit Source

Credit Source	Credits (Mg)	Percent of Total (%)
Fleet Average*	174,340,347	85.1
A/C Leakage	22,368,872	10.9
A/C Efficiency	8,227,627	4.0
Off-Cycle	5,632	0.0
Advanced Technology Vehicles	0	0.0
Total	**204,942,478**	**100.0**

* Fleet average credits in the early credits program do not include credits from flexible fuel vehicles.

Early credits from advanced technology vehicles are not specifically identifiable. In these early credit years, manufacturers producing advanced technology vehicles had two options available to them. They could simply incorporate these vehicles into their fleet averaging in the relevant model year (2009-2011), using zero grams per mile to represent the operation using grid

electricity (see the discussion of advanced technology vehicles in Section 3.4 for more information regarding this incentive). Alternatively, the program provides an option for manufacturers to exclude them from their fleet average in the 2009-2011 model years and essentially carry the vehicles forward into a future model year, where they must be used to offset a GHG deficit. General Motors and Mercedes-Benz chose the latter approach, while Nissan chose the former approach for their production of the Leaf electric car. Tesla, the only other manufacturer with qualifying vehicles, obviously used the former approach and generated credits in the 2010 and 2011 model year (carrying vehicles into a future model year would serve them no purpose since those vehicles have to be used to offset a deficit, and as a manufacturer solely of electric vehicles, Tesla will never accumulate a deficit). These credits are discussed in more detail in Section 3.4, which also presents production volumes of advanced technology vehicles for the 2009-2012 model years.

Finally, because of the fluid nature of credits from one year to the next, the March 2013 early credits report should serve as an historical reference based on performance at the end of the 2011 model year. This subsequent report regarding the 2012 model year, and the accompanying data for the 2009-2012 model years, should be used as the references from which to determine credit balances and overall performance at the conclusion of the 2012 model year.

3 Credits Reported From the 2012 Model Year

The mandatory compliance calculations that manufacturers must perform are (1) to determine whether or not they comply with manufacturer-specific, vehicle footprint-based CO_2 standards, and (2) to demonstrate compliance with N_2O and CH_4 exhaust emission standards. Compliance with fleet average CO_2 standards must be done separately for car and truck fleets at the end of each model year, using emission standards and fleet average values determined based on the actual production volumes of the model year. Compliance with N_2O and CH_4 standards is typically done in conjunction with emission tests for other pollutants, although there are additional options as described later in this report.

Manufacturers have several options to generate additional credits as part of their overall strategy to meet the standards. There are two distinct types of credit programs within the GHG program. One type of credit directly lowers a manufacturer's actual fleet average by virtue of being applied within the methodology for calculating the fleet average emissions. Examples of this type of credit include the credits available for flexible fuel vehicles and the advanced technology vehicle provisions that allow use of zero grams/mile for electric operation. Using this type of credit directly affects (lowers) a manufacturer's fleet average tailpipe emissions, and thus the fleet average calculation will be improved (i.e., by further increasing fleet average-based credits, or by eliminating a fleet average-based deficit that might otherwise be accrued). The second type of credit is independent of the calculation of a manufacturer's fleet average tailpipe values. Rather than giving credit by improving a manufacturer's fleet average via a credit mechanism, these credits (in megagrams) are calculated separately and are simply added to the manufacturer's overall ''bank'' of credits (or deficit, thereby reducing the deficit). This second type of credit includes credits for improvements to air conditioning system refrigerant leakage and/or efficiency, and implementation of technologies that reduce CO_2 emissions over driving conditions not captured by the test procedures used for compliance with the CO_2 standards (i.e., "off-cycle" reductions).

In the 2012 model year, manufacturers reported total credits of almost 39 million Mg. About 40 percent of these were accrued through the use of the optional credit programs for air conditioning systems, indicating a significant, real-world benefit as a result of the introduction of the technologies underlying these optional credit programs. Table 3-1 summarizes all the credits reported as earned in the 2012 model year, by the type of credit. Table 3.1 also reports a gram per mile equivalent of the credits, which are expressed in Mg. The credits are expressed in Megagrams (or, metric tons) because values in Megagrams can be determined for car and truck categories using a methodology that accounts for the differences in lifetime mileage, and thus results in a credit unit value that can be traded and transferred across categories without further adjustment. Credits expressed in grams per mile are not as easily transferrable and would require complicated adjustments in the event of transfers, and rather than try to manage and verify these calculations for every credit transfer, EPA chose to define credits in units that can be free of such calculations. A one gram per mile CO_2 reduction on a truck, for example, is worth more to the environment because trucks are driven more miles than cars, as reflected in the lifetime mileage values that EPA uses to determine the credits in Megagrams. To determine the gram per mile equivalents of the Megagram values in Table 3-1, a weighted vehicle miles traveled (VMT) value was calculated by weighting the car and truck VMT values used by the regulation (195,264

and 225,865 miles for cars and trucks, respectively) by the actual proportions of cars and trucks in the 2012 fleet (62 and 38 percent, respectively).[26]

Table 3-1. Total Reported Credits for the 2012 Model Year, By Credit Source

Credit Source	Credits (Mg)	Grams/Mile Equivalent
Fleet Average*	23,143,347	9.1
A/C Leakage	10,316,338	4.0
A/C Efficiency	5,202,895	2.0
Off-Cycle	5,822	0.0
Total	**38,668,402**	**15.2**

* Fleet average emissions include the effect of FFVs, which under the regulations are part of the fleet average calculation. The independent impact of FFVs is described in Section 3.1.3.

As seen in Table 3-1, the gram per mile equivalent values indicate what appears to be an industry "over-compliance" with the CO_2 standards by about 15 grams/mile. However, Table 3-1 reports only credits that were earned; the actual industry over-compliance is based on net credits, thus taking into account any deficits that were also generated in the model year. Some manufacturers failed to meet their 2012 model year CO_2 standards in either one or both of their fleets (car and truck), and thus generated fleet average deficits for the 2012 model year, which are not reported in Table 3-1, but are shown in Table 3-2 (these are the existing deficits before the use of credits carried over from a prior model or of purchased credits). Also not reported in Table 3-1 are deficits generated as a result of manufacturers' use of alternative N_2O and CH_4 exhaust emission standards, which must be offset with CO_2-equivalent credits (taking into account the differing – and higher – global warming potential of these emissions). Table 3-2 shows the total deficits (or negative credits) reported by the industry in the 2012 model year, in Megagrams and a grams/mile equivalent.

[26] Car and truck production volumes are shown in tables in Section 3.1.1. As noted earlier, Hyundai and Kia data, including production volumes, are excluded from the analysis in this report. If their production volumes were included, the proportions of cars and trucks would be 64 and 36 percent, respectively.

Table 3-2. Total Reported Deficits for the 2012 Model Year, By Deficit Source

Deficit Source	Deficit (Mg)	Grams/Mile Equivalent
Fleet Average*	(13,058,365)	(5.1)
N2O Alternative Standards	(320,723)	(0.1)
CH4 Alternative Standards	(236,146)	(0.1)
Total	**(13,615,234)**	**(5.3)**

* Fleet average emissions include the effect of FFVs, which under the regulations are part of the fleet average calculation. The independent impact of FFVs is described in Section 3.1.3.

The deficits reported by manufacturers combined with the credits result in total net credits for the 2012 model year of about 25 million Mg, as shown in Table 3-3 (the sum of values from Tables 3-1 and 3-2), yielding a net industry over-compliance with the 2012 model year CO_2 standards of about 10 grams/mile. For the summary purposes of Table 3-3, the tailpipe CO_2 and FFV credits (as described in Section 3.1.3) are shown separately, whereas they are combined in the previous two tables. For additional simplicity the two categories of air conditioning credits are combined into a single row, and the N_2O and CH_4 deficits are similarly combined. Thus, across the fleet, manufacturers over-complied with the 2012 standards by about 10 g/mi, indicating that consumers purchased vehicles with lower GHG emissions than were needed to meet the 2012 model year standards. The over-compliance of 10 g/mi indicates that CO_2 tailpipe emissions overall were about 5 g/mi better than the projections that EPA made in 2010.[27]

Table 3-3. Total Net Credits for the 2012 Model Year, By Credit Source

Credit Source	Credits (Mg)	Grams/Mile Equivalent
Tailpipe CO_2	(12,396,998)	(4.9)
Flexible Fuel Vehicles (FFV)	22,481,980	8.8
A/C Leakage & Efficiency	15,519,223	6.1
Off-Cycle	5,822	0.0
N_2O & CH_4 Deficits	(556,869)	(0.2)
Total	**25,053,168**	**9.8**

3.1 Credits Based on Fleet Average Tailpipe GHG Emissions

Fleet average CO_2 credits are based on the difference between the applicable footprint-based CO_2 standard and the actual fleet performance (in grams per mile), the expected lifetime miles (vehicle miles traveled, or VMT) of a vehicle, and the total vehicle production volume. The

[27] Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Final Rule, Federal Register 75 (7 May 2010): 25324-25728. See Table I.B.2-4, page 25331.

VMT used in this calculation for passenger cars is 195,264 miles, and for trucks is 225,865 miles. The equation that generates the metric tons (or Megagrams, Mg) of credits for a given fleet is as follows:

$$Credits\ (metric\ tons) = \frac{(Standard - Fleet\ Average) \times VMT \times Production\ Volume}{1{,}000{,}000}$$

Fleet average credits are earned by a manufacturer's fleet that performs better than the applicable fleet average exhaust emission standard. Manufacturers calculate their fleet average standards (separate standards are calculated for cars and trucks) using the footprint-based equations established in the regulations. A manufacturer's actual end-of-year fleet average is calculated similarly to the way in which CAFE values are calculated. First, manufacturers determine a CO_2-equivalent value for each vehicle model type based on laboratory testing over the EPA city and highway test cycles. The CO_2-equivalent value is a summation of the measured carbon-containing constituents of the exhaust emissions on a CO_2-equivalent basis. For gasoline and diesel vehicles this simply involves measurement of total hydrocarbons and carbon monoxide in addition to CO_2.[28] Second, manufacturers calculate a fleet average by weighting the CO_2 exhaust emissions for each model type by the production of that model type, as they do for the CAFE program. Again, this is done separately for cars and trucks. Finally, the manufacturer will compare its calculated standard with the fleet average CO_2 exhaust emissions performance that is actually achieved to determine the credits (or debits) that are generated, using the equation above. Both the determination of the applicable standard and the actual fleet average performance is done after the model year is complete and using final model year vehicle production data. Because manufacturers enter all the data necessary for these calculations into EPA's compliance data system (known as "Verify"), and because the data system performs these calculations, EPA has confidence that the calculations are being performed correctly and can be checked against the manufacturers' calculated results.

Manufacturers reported net fleet average credits totaling about 10 million Mg across the entire 2012 fleet, as shown in Table 3.1-1. These credits and deficits are based strictly on the exhaust emissions performance of each model as measured on EPA's City and Highway test procedures, and do not include the impact of air conditioning, credit transactions with other companies, and other optional credits (some of which are integral to the compliance strategy of some manufacturers). The fleet average credits discussed in this section also include credits resulting from the production of flexible-fuel vehicles. The credit for these vehicles is based on an adjustment to the exhaust emission test results, and thus the resulting credits become part of the fleet average calculation. Section 3.1.3 discusses the impact of flexible-fuel vehicles and breaks out their impact from the overall fleet average credits described in this section. It is important to note that this table, and the discussion in this section, relate only to fleet average credits and deficits (i.e., the credits resulting from comparing the fleet average exhaust emission test results – including flexible-fuel vehicles – to the calculated footprint-based CO_2 standard), and thus do not illustrate the final 2012 model year cumulative performance of the manufacturers. A

[28] The calculation becomes somewhat more complex for alternative fuel vehicles due to the different nature of their exhaust emissions. For example, for ethanol-fueled vehicles, the emission tests must measure ethanol, methanol, formaldehyde, and acetaldehyde in addition to CO_2.

manufacturer's final position at the end of the model year includes all additional credits from the optional credit programs and/or from credit transactions.

As Table 3.1-1 shows, for the 2012 model year alone about half of the companies generated net fleet average credits, while the remaining half accumulated net deficits in 2012. Overall across the industry the car fleet created net industry credits in the 2012 model year, although only half the manufacturers were responsible for more than offsetting the deficits of the others to create more than 17 million Mg of credits in the car fleet. Note that three manufacturers (Ford, Honda, and Toyota) were responsible for 90 percent of the total car credits that were accumulated. A different story emerged in the truck fleet, however, where the majority of manufacturers reported deficits, leading to an industry overall net deficit in the light truck sector.

Table 3.1-1. Reported Fleet Average Credits by Manufacturer and Fleet, 2012 Model Year

	Fleet Average Credits (Mg)			Grams/Mile Equivalent of Total Credits
Manufacturer	**Car**	**Truck**	**Total**	
Tesla	175,231	0	175,231	304.0
Coda	5,524	0	5,524	246.0
Fisker	46,694	0	46,694	169.0
Porsche*	23,163	175,185	198,348	31.8
Toyota	10,898,641	(489,377)	10,409,264	25.0
Honda	5,316,314	1,448,784	6,765,098	21.4
Mazda	749,725	(14,838)	734,887	13.0
Subaru	62,183	481,133	543,316	9.4
Ford	2,672,261	0	2,672,261	7.3
Mitsubishi	(10,139)	67,976	57,837	4.5
General Motors	0	(1,033,479)	(1,033,479)	(2.1)
Nissan	875,054	(2,248,843)	(1,373,789)	(5.5)
Volkswagen	(977,667)	(43,964)	(1,021,631)	(9.1)
BMW	(298,604)	(401,613)	(700,217)	(13.4)
Chrysler	(1,052,252)	(4,045,226)	(5,097,478)	(15.4)
Suzuki	(78,937)	(48,762)	(127,699)	(20.3)
Volvo	(255,674)	(79,002)	(334,676)	(22.5)
Mercedes-Benz*	(939,200)	(338,423)	(1,277,623)	(24.4)
Jaguar Land Rover*	(29,920)	(483,034)	(512,954)	(43.0)
Ferrari*	(43,932)	0	(43,932)	(149.0)
Total	**17,138,465**	**(7,053,483)**	**10,084,982**	**4.0**

* These companies used a temporary program that allowed all or part of their fleet to be subject to less stringent standards. See Section 3.1.2.

As noted above, only a few manufacturers accounted for a majority of the credits generated in the overall car fleet. Table 3.1-2 shows the top five generators of car credits, indicating that these five manufacturers accounted for 99 percent of the total car credits generated by the industry in

the 2012 model year. Note that this table illustrates that a larger quantity of credits does not necessarily imply that a manufacturer has achieved better performance relative to its unique, manufacturer-specific footprint-based fleet average CO_2 standard. This is because the credits are based on production volume; thus, a relatively small number of credits can mean very good performance relative to the standards. For example, while Mazda accounts for only four percent of the reported fleet average credits on a per vehicle basis, Mazda over-complied significantly with an 18 grams/mile per vehicle car credit.

Table 3.1-3 shows the four manufacturers that generated credits in the truck fleet. Honda generated almost three quarters of the 2012 model year truck credits, while Subaru almost made up the remaining quarter, with Mitsubishi accounting for several percent and Ford "breaking even" on their trucks (meaning that their fleet average performance matched their calculated footprint-based CO_2 standard). Tables 3.1-2 and 3.1-3 exclude those manufacturers meeting alternative less stringent standards as described in Section 3.1.2.

Table 3.1-2. Total 2012 Model Year Fleet Average Car Credits - Top Five Manufacturers in Primary Program

Manufacturer	Fleet Average Credits (Mg)	Percent of Total Car Credits	Grams/Mile Equivalent for Car Fleet
Toyota	10,898,641	52%	43.0
Honda	5,316,314	26%	26.0
Ford	2,672,261	13%	13.0
Nissan	875,054	4%	5.0
Mazda	749,725	4%	18.0
Total	**20,511,995**	**99%**	**N/A**

Table 3.1-3. Total 2012 Model Year Fleet Average Truck Credits – All Manufacturers in Primary Program

Manufacturer	Fleet Average Credits (Mg)	Percent of Total Truck Credits	Grams/Mile Equivalent for Car Fleet
Honda	1,448,784	73%	13.0
Subaru	481,133	24%	13.0
Mitsubishi	67,976	3%	24.1
Ford	-	0%	0.0
Total	**1,997,893**	**100%**	**N/A**

Further details regarding fleet average credits are provided later in this report. In particular, while Table 3.1-1 shows the broad picture of manufacturers' compliance with fleet average exhaust standards (including the impact of flexible-fuel vehicle credits), there are some important underlying details. For example, several manufacturers made use of the Temporary Lead-time Allowance Alternative Standards (TLAAS) program, which allows some lower volume

manufacturers to apply less stringent standards to a limited number of vehicles in the early model years of the program. These manufacturers, their credits, and the limitations of the TLAAS program are discussed in Section 3.1.2. And, as noted above, Table 3.1-1 is simply a reflection of how well manufacturers did in meeting their footprint-based fleet average standards without the application of additional credits from air conditioning, off-cycle technologies, or credit purchases.

Readers should refer to the Appendix and to the downloadable data for the complete detailed values underlying the fleet average credits, such as the applicable manufacturer-specific fleet average emission standards and the reported fleet average performance for each manufacturer.

3.1.1 Manufacturers in the Primary Standards Program

The fleet average credits described above were generated by manufacturers complying with different sets of emission standards as allowed under the regulations. Most manufacturers are required to comply with the "primary" emission standards, meaning those that are the default mandatory standards in the regulations. Several manufacturers qualify for an alternative, less stringent set of standards, known as the Temporary Lead-Time Allowance Alternative Standards (TLAAS). For the 2012 model year, the primary standards program includes vehicles from all manufacturers except Ferrari and Porsche, both of which assigned all of their 2012 production into the TLAAS program. Two other manufacturers with vehicles in the TLAAS program – Jaguar-Land Rover and Mercedes-Benz – also have vehicles within the Primary program, and these Primary program vehicles are shown in Table 3.1.1-1. The compliance of these manufacturers and a more detailed description of the TLAAS program is in the following section. Table 3.1.1-1 lays out the details of fleet average credits and deficits accumulated by manufacturers with vehicles in the primary standards program. As described in the following section, the TLAAS program is available only to a limited number of lower volume manufacturers who qualify for the program based on 2009 model year sales volumes. Most manufacturers do not qualify for the TLAAS program, and must demonstrate compliance with the base primary program as described in the regulations.

At the end of each model year, manufacturers perform two significant calculations, the results of which are displayed in Table 3.1.1-1. Using the vehicle footprint equations and the specified parameters in the regulations that define the footprint "curves" (which are graphically displayed in Figure 3.1.1-1 for the 2012 model year), manufacturers must determine the CO_2 fleet average standard applicable to each vehicle category (car and truck). Each standard is a post-model year sales-weighting of the CO_2 values (as described by the footprint target curves shown in Figure 3.1.1-1) for all of the footprint values in a manufacturer's fleet. Manufacturers also determine a fleet average CO_2 value, reflecting their actual performance for a model year and separately for cars and trucks, by weighting the CO_2 emissions value for each model by the sales of that model. Finally, using these emission values coupled with the production volume for each vehicle category (shown in Table 3.1.1-1), fleet average based credits or deficits are calculated using the equation specified in Section 3.1. The resulting values include FFV credits, but do not include air conditioning and other credits and therefore are not final compliance values. The CO_2 standards and fleet average values shown in the bottom row of Table 3.1.1 are production-weighted averages of the manufacturer-specific values.

Figure 3.1.1-1. 2012 Model Year Footprint Target Curves

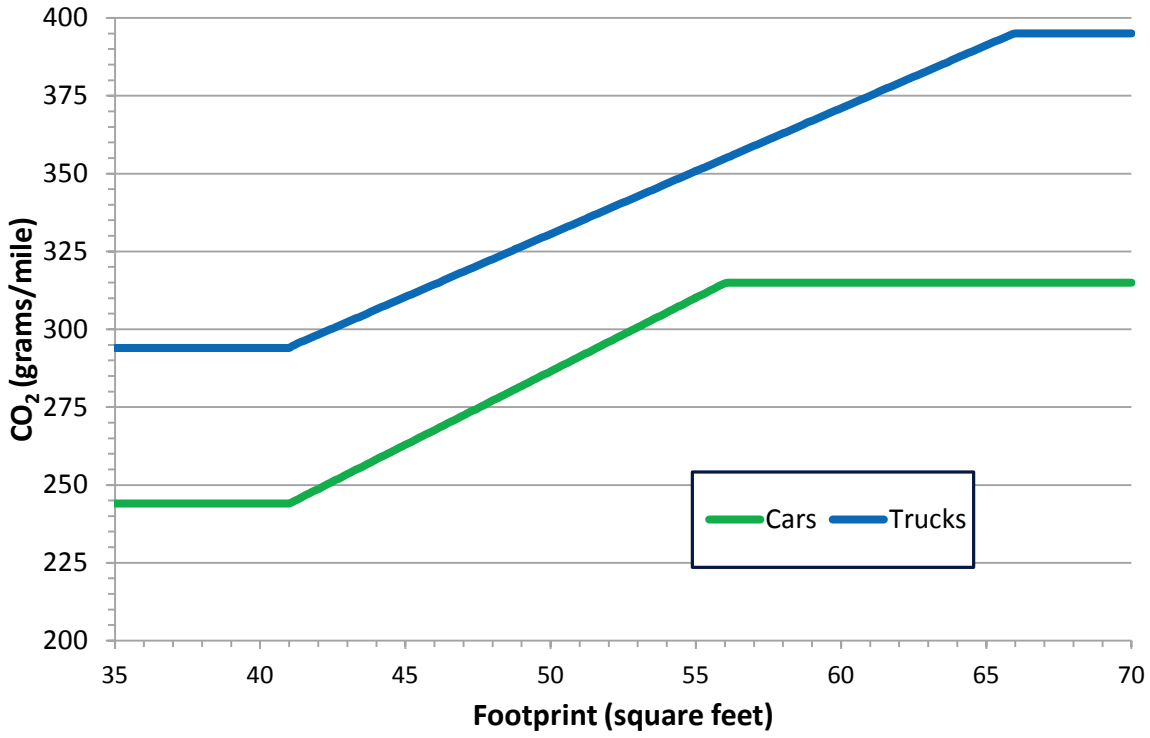


Table 3.1.1-1. Reported Fleet Average Credit Detail for Manufacturers with Primary Program Fleets, 2012 Model Year

	Car				Truck				Total	
Manufacturer	CO_2 Standard (g/mi)	Average (g/mi)	Production Volume	Credits (Mg)	CO_2 Standard (g/mi)	Average (g/mi)	Production Volume	Credits (Mg)	Production Volume	Credits (Mg)
BMW	269	277	191,154	(298,604)	336	363	65,856	(401,613)	257,010	(700,217)
Chrysler	277	287	538,887	(1,052,252)	345	363	994,996	(4,045,226)	1,533,883	(5,097,478)
Coda	246	0	115	5,524	N/A	N/A	N/A	N/A	115	5,524
Fisker	315	146	1,415	46,694	N/A	N/A	N/A	N/A	1,415	46,694
Ford	265	252	1,052,721	2,672,261	364	364	701,602	0	1,754,323	2,672,261
General Motors	272	272	1,449,244	0	369	374	915,130	(1,033,479)	2,364,374	(1,033,479)
Honda	263	237	1,047,165	5,316,314	333	320	493,414	1,448,784	1,540,579	6,765,098
Jaguar Land Rover	N/A	N/A	N/A	N/A	316	303	9,086	26,679	9,086	26,679
Mazda	259	241	213,308	749,725	323	324	65,696	(14,838)	279,004	734,887
Mercedes-Benz	271	298	163,247	(860,659)	335	368	61,343	(457,223)	224,590	(1,317,882)
Mitsubishi	261	262	51,927	(10,139)	307	283	12,540	67,976	64,467	57,837
Nissan	263	258	896,278	875,054	337	367	331,886	(2,248,843)	1,228,164	(1,373,789)
Subaru	260	257	106,152	62,183	309	296	163,860	481,133	270,012	543,316
Suzuki	251	267	25,266	(78,937)	325	361	5,997	(48,762)	31,263	(127,699)
Tesla	304	0	2,952	175,231	N/A	N/A	N/A	N/A	2,952	175,231
Toyota	264	221	1,298,021	10,898,641	342	345	722,227	(489,377)	2,020,248	10,409,264
Volkswagen	263	273	500,690	(977,667)	327	330	64,882	(43,964)	565,572	(1,021,631)
Volvo	272	297	52,375	(255,674)	325	343	19,432	(79,002)	71,807	(334,676)
Total			**7,590,917**	**17,267,695**			**4,627,947**	**(6,837,755)**	**12,218,864**	**10,429,940**

Note: This table shows only the inputs and results of the fleet average credit calculation. It does not include credits from air conditioning or other programs and does not completely represent either the cumulative performance of a manufacturer in the 2012 model year or their final status at the end of the model year.

3.1.2 Manufacturers in the TLAAS Program

EPA established the Temporary Lead-time Alternative Allowance Standards (TLAAS) to assist manufacturers with limited product lines that may be especially challenged in the early years of EPA's GHG program. Manufacturers with narrow product offerings may not be able to take full advantage of averaging or other program flexibilities due to the limited scope of the types of vehicles they sell, and they may need additional lead time.

The TLAAS program applies only to manufacturers with 2009 model year U.S. sales of less than 400,000, and, except as noted below, is available during the 2012-2015 model years. Under this program, a manufacturer is allowed to treat a portion of its fleet as a separate averaging fleet to which a less stringent CO_2 standard applies. Specifically, a qualifying manufacturer may put up to 100,000 vehicles (combined cars and trucks) under the less stringent standards over the four model years from 2012 through 2015 (this is a total allowance, not an annual allowance). The CO_2 standard applied to this limited fleet is 1.25 times the standard that would otherwise be calculated for the fleet under the primary program (i.e., the TLAAS standard is 25 percent higher). Manufacturers with 2009 model year U.S. sales between 5,000 and 50,000 vehicles are allowed an additional 150,000 vehicles (for a total of 250,000), and can extend the program through the 2016 model year (for a total eligibility of five model years).

All manufacturers participating in the TLAAS program are subject to a number of restrictions designed to ensure only those manufacturers that truly need it use it. Under the TLAAS program manufacturers may not sell credits, they may not bank credits that are achieved by their non-TLAAS fleets, they must use up any banked credits before utilizing a TLAAS fleet, and the movement of credits between a participating manufacturer's TLAAS and non-TLAAS fleets is restricted.

The fleet average details for manufacturers participating in the TLAAS program are shown in Table 3.1.2-1. There are four possible fleets for emissions averaging and credit or deficit calculation under the TLAAS program: both cars and trucks in either the Primary or TLAAS program. Manufacturers employed a variety of strategies in the use of the TLAAS standards. Jaguar-Land Rover placed all of their cars and about 75 percent of their trucks in TLAAS fleets, using almost half of their initial allocation of 100,000 vehicles. Mercedes-Benz, with higher production volumes of cars and trucks than the other manufacturers using the TLAAS standards, limited their TLAAS fleets to about one third of the allowed allocation of 100,000 vehicles, leaving them room to continue use of the TLAAS standards in upcoming model years. Ferrari and Porsche, with the lowest production volumes of these four participating manufacturers, placed all of their vehicles under the TLAAS standards. Table 3.1.2-1 provides details for the vehicles that these four manufacturers placed in TLAAS fleets. As noted earlier, both Mercedes-Benz and Jaguar-Land Rover also have vehicles that are not subject to the less stringent TLAAS standards and are instead subject to Primary program standards. Their Primary program vehicles are included above in Table 3.1.1-1.

Table 3.1.2-1. Reported Fleet Average Credit Detail for TLAAS Program Fleets, 2012 Model Year

	Car				Truck				Total	
Manufacturer	**Standard (g/mi)**	**Average (g/mi)**	**Production Volume**	**Credits (Mg)**	**Standard (g/mi)**	**Average (g/mi)**	**Production Volume**	**Credits (Mg)**	**Production Volume**	**Credits (Mg)**
Ferrari	345	494	1,510	(43,932)	-	-	-	-	1,510	(43,932)
Jaguar Land Rover	364	376	12,769	(29,920)	408	477	32,706	(509,713)	45,475	(539,633)
Mercedes-Benz	368	406	10,585	(78,541)	434	408	20,230	118,800	30,815	40,259
Porsche	332	325	16,946	23,163	422	362	12,927	175,185	29,873	198,348
Total			**41,810**	**(129,230)**			**65,863**	**(215,728)**	**107,673**	**(344,958)**

3.1.3 Flexible Fuel and Natural Gas Vehicle Credits

Unlike the optional credits reported in the following sections of this report, which are independently calculated and separate from the fleet average credits, flexible fuel vehicles (FFV) and compressed natural gas (CNG) vehicle credits are essentially built in to the fleet average calculation and thus require some additional explanation and documentation. FFV credits are included in the values shown in Sections 3.1.1 and 3.1.2, although they are not separately identifiable in those sections. EPA's GHG program contains credits for flexible-fuel vehicles (FFVs) and alternative fuel vehicles starting in the 2012 model year. FFVs are dual-fuel vehicles, i.e., vehicles that can run both on an alternative fuel and conventional fuel. Most FFVs are E–85 vehicles, which can run on a mixture of up to 85 percent ethanol and the remainder gasoline. Dedicated alternative fuel vehicles are vehicles that run exclusively on an alternative fuel (e.g., compressed natural gas).

EPA's GHG program requires that FFV and other, similar alternative fuel vehicle credits be calculated as a part of the calculation of a manufacturer's overall fleet average greenhouse gas exhaust emissions. Under the GHG program, EPA allows FFV credits corresponding to the amounts allowed in the CAFE program under the statutory provisions, but only for the 2012 to 2015 model years. As with the CAFE program, the GHG program bases FFV credits on the assumption that the vehicles would operate 50% of the time on the alternative fuel and 50% of the time on conventional fuel, resulting in CO_2 emissions that are based on an arithmetic average of alternative fuel and conventional fuel CO_2 emissions. The CO_2 emissions measurement on the alternative fuel is multiplied by a 0.15 volumetric conversion factor. Through this mechanism a gallon of alternative fuel is deemed to contain 0.15 gallons of gasoline fuel. Again, this approach is only applicable for the 2012–2015 model years.

For example, for a flexible-fuel vehicle that emits 330 g/mi CO_2 while operating on E–85 and 350 g/mi CO_2 while operating on gasoline, the resulting CO_2 level to be used in the manufacturer's fleet average calculation would be:

$$\mathrm{CO_2} = \frac{[(330 \times 0.15) + 350]}{2} = 199.8 \text{ g/mi}$$

EPA realizes that by using the CAFE approach—including the 0.15 factor—the CO_2 emissions value for the vehicle is calculated to be significantly lower than it actually would be otherwise, even if the vehicle were assumed to operate on the alternative fuel at all times. This represents the short-term "credit" being provided to FFVs. Under the GHG program, FFV credits are available only through the 2015 model year; starting in model year 2016, EPA's GHG program will allow FFV credits only based on a demonstration that the alternative fuel is actually being used in the vehicles and the actual GHG performance for the vehicle run on that alternative fuel. Similarly, the GHG credit for dedicated alternative fuel vehicles, such as those that use CNG, is calculated by measuring the CO_2 emissions and then multiplying those emissions by 0.15. Again, this is a short-term credit that expires after the 2015 model year, at which point the GHG performance becomes the actual measured emissions of the vehicle without adjustment. And, as noted earlier, EPA's standards are predicated on the use of FFV credits in the early model years of the program.

In the 2012 model year the dual-fuel credit limit in the CAFE program is 1.2 mpg across a manufacturer's fleet (dedicated alternative fuel vehicles are not subject to this limit on credits). In other words, FFVs may not increase a manufacturer's average fuel economy by more than 1.2 mpg. To parallel the CAFE limitations, the GHG program contains a similar credit limit, but calculated in CO_2 space based on each manufacturer's unique fleet average performance. EPA chose this approach because of the non-linearity between mpg and CO_2 emissions. For example, a 1.2 mpg increase from a base of 15 mpg represents a CO_2 decrease of about 44 g/mi, while a 1.2 mpg increase from a base of 30 mpg represents a CO_2 decrease of about 11 g/mi. Thus, the CO_2 reduction that manufacturers may get from the FFV credits for a given fleet is limited to the CO_2 value comparable to 1.2 mpg and is calculated from a manufacturer's specific fleet average performance.

As noted earlier, the FFV and CNG credits are included in the calculation of the fleet average CO_2 emission values. For example, Ford's fleet average for its car fleet of 252 g/mi as shown in Table 3.1.1-1 includes these credits, i.e., without the FFV credit Ford's fleet average would be higher than 252 g/mi. Seven manufacturers produced FFVs in the 2012 model year to varying degrees, as shown below in Table 3.1.3-1. Clearly, Chrysler, Ford, and General Motors are currently the most invested in ethanol as an alternative fuel, producing the overwhelming majority of vehicles capable of operating on E85. Note that the number of models is based on EPA's "model type" designation, and is not equivalent to "nameplate" as some might tend to think of it. Generally speaking, a model type is a unique combination of a nameplate (e.g., Silverado), an engine (e.g., 6 cylinder), a drive system (e.g., 4 wheel drive), and a transmission (e.g., 6-speed automatic). Thus a single nameplate that is offered with two engines, in both two- and four-wheel drive, and in manual and automatic transmissions, will result in eight different model types. For example, the four Nissan FFV models shown in Table 3.1.3-1 are made up of two- and four-wheel drive versions of two nameplates, the Titan and the Armada. Most of these manufacturers tended to focus their FFV production in the truck segment. Of General Motors' 80 FFV model types, only ten are cars. Six of Ford's 28 FFV model types are cars, as are seven of Chrysler's 18 FFV model types. Nissan and Toyota's FFVs are exclusively trucks, while the European companies tended to focus their limited number of FFVs in the car category.[29]

[29] See the downloadable fuel economy data at http://www.fueleconomy.gov/feg/download.shtml.

Table 3.1.3-1. Production of FFVs and CNG vehicles by Manufacturer, 2012 Model Year

Manufacturer	No. of Models	FFV & CNG Production Volume		
		Cars	Trucks	Total
Chrysler	18	105,174	453,399	558,573
Ford	28	174,567	323,430	497,997
General Motors	80	520,116	511,141	1,031,257
Honda[1]	1	3,307		3,307
Mercedes-Benz	6	13,096	8,289	21,385
Nissan	4		24,154	24,154
Toyota	2		31,670	
Volkswagen	5	2,060		2,060
Total	**151**	**815,013**	**1,352,083**	**2,135,426**

[1] Honda is the only major manufacturer selling a mass-production CNG vehicle, the Civic Natural Gas AT. All other vehicles in this table are gasoline-ethanol FFVs.

Table 3.1.3-2 shows the results of the calculations described above for each manufacturer with FFV sales in the 2012 model year. Column B is the fleet average CO_2 value calculated for each fleet as if each FFV in that fleet is operated only on gasoline, i.e., the emissions value for each FFV ignores operation on E85. This is the fleet value that represents no impact as a result of FFVs. Column C is the fleet average CO_2 value that incorporates the full effect of the FFV credits without any limitation, using the 0.15 factor for E85 CO_2 emissions and an even 50/50 weighting of this value with the gasoline CO_2 emissions value. However, because the EPA GHG program limits the benefit that manufacturers can get from this FFV calculation, this column does not necessarily represent the final fleet average for a manufacturer.

As described above, EPA requires that the benefit of FFVs be limited, as it is in the CAFE program. This limit, which is based on a manufacturer's baseline value (Column B), is shown in Column D. Thus, FFVs can allow a manufacturer to reduce their baseline emissions value by no more than the amount in Column D. For example, if the benefit were not capped, General Motors could reduce their truck fleet average CO_2 emissions by 100 g/mi (i.e., from 397 to 297 g/mi). However, they are limited to a more modest reduction of 23 g/mi, leading to a final truck fleet average of 374 g/mi. Chrysler, Ford, and General Motors have routinely maximized their FFV benefit in the CAFE program, thus it is no surprise, given the parallel construct of the GHG program, that this is also the case under the GHG program. These companies have, in fact, been producing far more FFVs than are required to maximize the CAFE or GHG benefit. The Japanese and European manufacturers, on the other hand, have not historically ventured into FFV production to the extent that the Detroit-based companies have. For example, Toyota could "claim" almost 18 g/mi of FFV credits, and yet their FFV sales only give them 9 g/mi, half of the total amount they would be allowed under the regulatory limits. The total volume of credits accounted for by FFVs is equivalent to 8.8 grams/mile across the entire 2012 model year fleet of vehicles.

Note that reporting of FFV credits, like a number of aspects of the GHG program, could be complicated by the use of the TLAAS program by some manufacturers. However, Mercedes-

Benz (the only manufacturer using the TLAAS standards that produces FFVs) placed all of their FFVs in the Primary fleets, and none in the TLAAS fleets. Thus their entries in Table 3.1.3-2 reflect only the vehicles in the Primary fleets. If they had placed FFVs in the TLAAS fleets, the calculations would be essentially the same as for any other fleet, with the difference being a 25 percent less stringent standard and some additional restrictions on the use of credits. Thus FFV benefits can accrue to a TLAAS fleet, and, like any fleet, are reflected in the final fleet average value used to determine compliance for a given fleet (Primary or TLAAS), as is shown in Table 3.1.3-2.

No credits can be individually attributed to the Honda CNG vehicle. Because of its relatively low sales volume, the overall rounded fleet average for Honda's car fleet is unaffected by the credited GHG value for the 2012 CNG Civic.

Table 3.1.3-2. Fleet Average GHG Benefits from FFV Production, by Manufacturer and Fleet

	A	B	C	D	E	F	G
Manufacturer	**Fleet**	**Baseline (g/mi)**	**With FFVs (g/mi)**	**Allowed Benefit (g/mi)**	**Final Fleet Average (g/mi)**	**Final FFV Credit (g/mi)**	**FFV Credits (Mg)**
Chrysler	Car	300	274	13	287	13	1,367,928
	Truck	384	315	21	363	21	4,719,430
Ford	Car	261	242	9	252	9	1,850,027
	Truck	385	304	21	364	21	3,327,814
General Motors	Car	283	236	11	272	11	3,112,837
	Truck	397	297	23	374	23	4,754,004
Mercedes-Benz	Car	310	298	14	298	12	382,515
	Truck	388	368	22	368	20	277,105
Nissan	Truck	382	367	21	367	15	1,124,421
Toyota	Truck	354	345	18	345	9	1,468,132
Volkswagen	Car	274	273	10	273	1	97,767
Total							**22,481,980**
Gram per mile equivalent impact across entire industry fleet							**8.8**

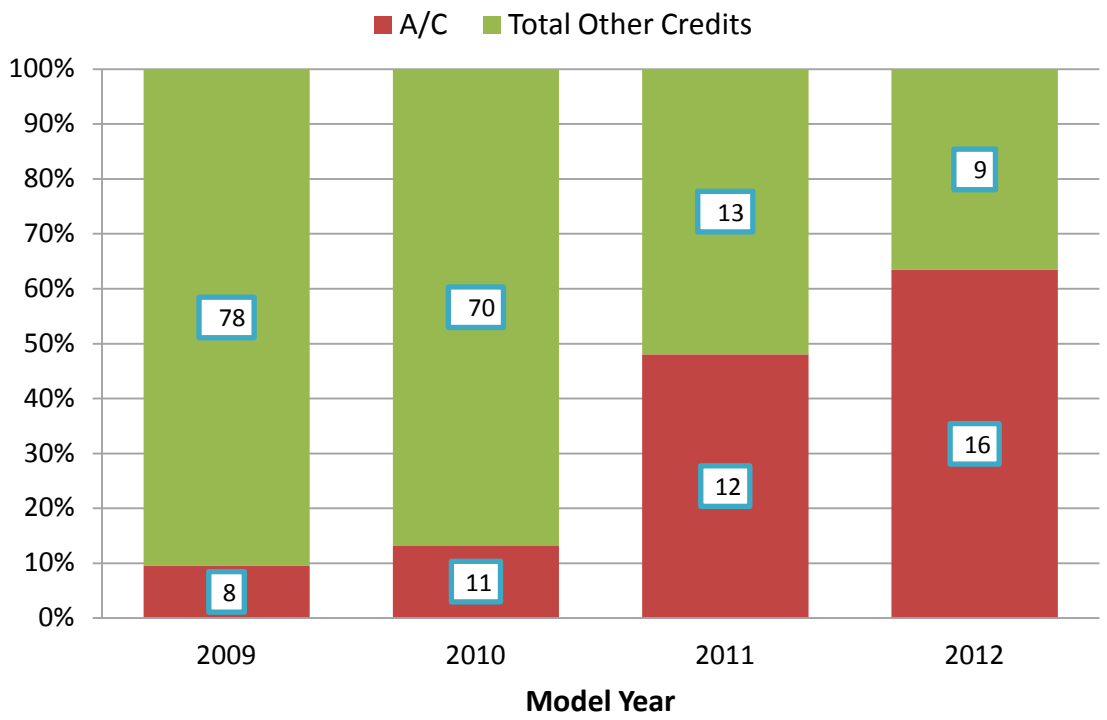
3.2 Credits Based on Air Conditioning Systems

Over 95% of the new cars and light trucks in the United States are equipped with air conditioning (A/C) systems. There are two mechanisms by which A/C systems contribute to the emissions of greenhouse gases: through leakage of hydrofluorocarbon refrigerants into the atmosphere (sometimes called "direct emissions") and through the consumption of fuel to provide mechanical power to the A/C system (sometimes called "indirect emissions"). The high global warming potential of the current automotive refrigerant means that leakage of a small amount of refrigerant will have a far greater impact on global warming than emissions of a similar amount of CO_2. The impacts of refrigerant leakage can be reduced significantly by systems that incorporate leak-tight components, or, ultimately, by using a refrigerant with a

lower global warming potential. The A/C system also contributes to increased tailpipe CO_2 emissions through the additional work required to operate the compressor, fans, and blowers. This additional power demand is ultimately met by using additional fuel, which is converted into CO_2 by the engine during combustion and exhausted through the tailpipe. These emissions can be reduced by increasing the overall efficiency of an A/C system, thus reducing the additional load on the engine from A/C operation, which in turn means a reduction in fuel consumption and a commensurate reduction in GHG emissions. Manufacturers may generate and use credits for improved A/C systems in complying with the CO_2 fleet average standards taking effect in the 2012 model year (or otherwise to be able to bank or trade the credits). These provisions were also used in the 2009-2011 model years to generate early credits, prior to the 2012 model year.

As was the case with the early credit program, a majority of manufacturers chose to use the A/C credit provisions as part of their compliance demonstration in the 2012 model year. The same manufacturers who used these provisions to generate early credits also reported A/C credits in the 2012 model year, and Ferrari and Jaguar Land Rover (not early credit participants) also reported A/C credits in 2012, bringing the number of manufacturers who are reporting credits for A/C systems to thirteen. Most manufacturers who also reported credits for the 2009-2011 model years were able to increase their A/C credits in 2012 relative to the early credit years. In fact, as the A/C credits have increased and the fleet average credits have decreased due to increasingly stringent emission targets over the 2009-2012 model years, the A/C credits now represent a significant portion of the overall reported credits, as shown in Figure 3.2-1. The values reflected in Figure 3.2-1 are the total industry credits for those eleven manufacturers with continuous use of A/C credits in the 2009-2012 model years. For those eleven manufacturers as a whole, the total A/C credits have risen in importance to the point where they make up about 60 percent of the total credits generated.

Figure 3.2-1. A/C Credits Relative to Total Credits Earned by Manufacturers for 2009-2012 Model Years (millions of Mg)



The A/C provisions are structured as additional and optional credits, unlike the CO_2 standards for which manufacturers must demonstrate compliance using the EPA test procedures. Those tests do not measure either A/C refrigerant leakage or the increase in tailpipe CO_2 emissions attributable to the additional engine load of A/C systems. Because it is optional to include A/C-related GHG emission reductions as an input to a manufacturer's compliance demonstration, the A/C provisions are viewed as an additional program that credits manufacturers for implementing A/C technologies that result in real-world reductions in GHG emissions. A summary of the air conditioning credits reported by the industry for all model years, including the early credit program years, is shown in Table 3.2-1, and Table 3.2-2 shows the total air conditioning credits (combined leakage and efficiency credits) reported by each manufacturer in the 2012 model year.

Table 3.2-1. Reported Air Conditioning Credits by A/C Credit Type and Model Year (Mg)

A/C Credit Type	2009	2010	2011	2012	Total
A/C Efficiency	2,057,396	2,731,622	3,438,609	5,202,895	13,430,522
A/C Leakage	6,104,668	7,971,855	8,292,349	10,316,338	32,685,210
Total A/C	**8,162,064**	**10,703,477**	**11,730,958**	**15,519,233**	**46,115,732**

Table 3.2-2. Reported Air Conditioning Credits by Manufacturer, 2012 Model Year(Mg)

Manufacturer	A/C Leakage Credits	A/C Efficiency Credits	Total A/C Credits	Gram/Mile Equivalent of Total A/C Credits
BMW	248,044	180,516	428,560	8.2
Chrysler	2,400,958	833,053	3,234,011	9.8
Ferrari	1,858	1,091	2,949	10.0
Ford	1,752,555	102,848	1,855,403	5.1
General Motors	3,071,779	929,844	4,001,643	8.2
Honda	536,504	549,649	1,086,153	3.4
Jaguar Land Rover	46,310	42,612	88,922	7.5
Mercedes-Benz	269,939	258,961	528,900	10.1
Nissan	184,909	458,943	643,852	2.6
Tesla	-	3,286	3,286	5.7
Toyota	1,425,968	1,327,777	2,753,745	6.6
Volkswagen	280,173	452,155	732,328	6.5
Volvo	97,321	62,160	159,481	10.9
Total	**10,316,338**	**5,202,895**	**15,519,233**	**6.1**

3.2.1 Air Conditioning Leakage Credits

A manufacturer choosing to generate A/C leakage credits with a specific A/C system is required to calculate a leakage "score" for the A/C system. This score is based on the number, performance, and technology of the components, fittings, seals, and hoses of the A/C system. This score, which is determined in grams per year, is calculated using the procedures specified by the Society of Automotive Engineers Surface Vehicle Standard J2727. The score is subsequently converted to a grams/mile credit value for consistency with the units of GHG exhaust emissions. The grams/mile value is used to calculate the total tons of credits attributable to an A/C system by accounting for the global warming potential (GWP) of the refrigerant, the VMT of the vehicle class (car or truck), and the production volume of the A/C system. All leakage credits in the 2012 model year are based on improvements to the components to reduce leakage and not on the use of alternative low-GWP refrigerants.

Twelve manufacturers reported A/C leakage credits in the 2012 model year, as shown in Table 3.2.1-1. These manufacturers reported more than 10 million Mg of A/C leakage credits in 2012, or about one quarter of all reported credits.

Table 3.2.1-1. Reported Air Conditioning Leakage Credits by Manufacturer and Fleet, 2012 Model Year (Mg)

Manufacturer	Car	Truck	Total	Gram/Mile Equivalent of Total Credits
BMW	146,683	101,361	248,044	4.8
Chrysler	652,554	1,748,404	2,400,958	7.3
Ferrari	1,858	-	1,858	6.3
Ford	648,752	1,103,803	1,752,555	4.8
General Motors	1,597,485	1,474,314	3,071,779	6.3
Honda	282,652	253,852	536,504	1.7
Jaguar Land Rover	6,634	39,676	46,310	3.9
Mercedes-Benz	144,381	125,558	269,939	5.2
Nissan	37,027	147,882	184,909	0.7
Toyota	872,335	553,633	1,425,968	3.4
Volkswagen	221,065	59,108	280,173	2.5
Volvo	64,281	33,040	97,321	6.7
Total	**4,675,707**	**5,640,631**	**10,316,338**	**4.0**

3.2.2 Air Conditioning Efficiency Credits

Manufacturers that make improvements in their air conditioning systems to increase efficiency, and thus reduce CO_2 emissions due to air conditioning system operation, may be eligible for air conditioning efficiency credits. Most of the additional load on the engine from air conditioning systems comes from the compressor, which pumps the refrigerant around the system loop. A significant additional load on the engine may also come from electric or hydraulic fans, which are used to move air across the condenser, and from the electric blower, which is used to move air across the evaporator and into the cabin. Manufacturers have several technological options for improving efficiency, including more efficient compressors, fans, and motors, and system controls that avoid over-chilling the air (and subsequently re-heating it to provide the desired air temperature with an associated loss of efficiency). For vehicles equipped with automatic climate-control systems, real-time adjustment of several aspects of the overall system (such as engaging the full capacity of the cooling system only when it is needed, and maximizing the use of recirculated air) can result in improved efficiency. The regulations provide manufacturers with a "menu" of technologies and associated credit values (in grams/mile of CO_2). The total tons of credits are then based on the total volume of vehicles in a model year using these technologies.

Thirteen manufacturers used the provisions that allow credits based on improvements to the overall efficiency of the A/C system, as shown in Table 3.2.2-1. These manufacturers reported a total of about 5 million Mg of CO_2 credits in the 2012 model year, or almost 13% of the total credits reported by the industry and accounting for about two grams per mile across the 2012 fleet (see Table 3-1).

Table 3.2.2-1. Reported Air Conditioning Efficiency Credits by Manufacturer and Fleet, 2012 Model Year (Mg)

Manufacturer	Car	Truck	Total	Gram/Mile Equivalent of Total Credits
BMW	116,556	63,960	180,516	3.5
Chrysler	323,190	509,863	833,053	2.5
Ferrari	1,091	-	1,091	3.7
Ford	40,776	62,072	102,848	0.3
General Motors	652,193	277,651	929,844	1.9
Honda	360,193	189,456	549,649	1.7
Jaguar Land Rover	4,771	37,841	42,612	3.6
Mercedes-Benz	175,884	83,077	258,961	4.9
Nissan	327,145	131,798	458,943	1.8
Tesla	3,286	N/A	3,286	5.7
Toyota	924,609	403,168	1,327,777	3.2
Volkswagen	374,795	77,360	452,155	4.0
Volvo	43,280	18,880	62,160	4.3
Total	**3,347,769**	**1,855,126**	**5,202,895**	**2.0**

3.3 "Off-Cycle" Credits

General Motors (GM) requested, and was subsequently granted, off-cycle credits for a technology used on certain gasoline-electric hybrid vehicles. The off-cycle credits reported by GM are shown in Table 3.3-1. The low volume of these credits is not sufficient to generate a gram per mile equivalent benefit that can be separately calculated for the GM fleet. The technology is an auxiliary electric pump, which keeps engine coolant circulating in cold weather while the vehicle is stopped and the engine is off. GM received off-cycle credits in the early credits program for hybrid full size pick-up trucks that were equipped with this technology. In the 2012 model year, the technology was expanded to include two Buick hybrid passenger car models. These hybrid vehicles feature engine stop/start capability for improved fuel economy, and as a result the engine can frequently be turned off when the vehicle is stopped, such as at a traffic light, resulting in real-world fuel savings. However, during cold weather, a hybrid vehicle without the auxiliary heater pump would need to keep the engine idling during the stop periods solely to maintain coolant flow to the heater to maintain a comfortable temperature inside the vehicle. This would reduce the fuel economy benefits of the stop/start feature during cold weather, which is an "off-cycle" temperature condition not captured by the greenhouse gas test methods. Note that starting with the 2014 model year, the regulations provide a "menu" of off-cycle technologies and associated credits for each technology. Manufacturers implementing engine idle stop/start technologies may receive off-cycle credits for those technologies, and the addition of an auxiliary heat pump (or system that achieves the same result) to these vehicles will gain additional off-cycle credits. Manufacturers may also seek additional off-cycle credits for technologies not listed on the menu based on data and analyses submitted to EPA for approval.

In the fall of 2013, Mercedes-Benz requested additional, off-cycle credits for their stop-start systems for the 2012-2015 model years. However, at the time of this report, those credits have not been approved by EPA, and are thus not included in this report. Readers can find additional information regarding this credit application on EPA's website at http://epa.gov/otaq/regs/ld-hwy/greenhouse/ld-ghg.htm.

Table 3.3-1. Reported Off-Cycle Credits by Manufacturer and Fleet, 2012 Model Year (Mg)

Manufacturer	Car	Truck	Total
GM	4,984	838	5,822
Total	**4,984**	**838**	**5,822**

3.4 Advanced Technology Vehicle Incentives

EPA's GHG program contains incentives for advanced technology vehicles. Specifically, these incentives apply to electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles. For the 2012-2016 model years, the incentive program allows electric vehicles and fuel cell vehicles to use a zero grams/mile compliance value, and plug-in hybrid electric vehicles may use zero grams/mile to represent the use of grid electricity (i.e., only emissions are "counted" from the gasoline engine operation). Use of the zero grams/mile option is limited to the first 200,000 qualified vehicles produced by a manufacturer in the 2012-2016 model years. This limitation can be expanded to 300,000 vehicles for any manufacturer that produced at least 25,000 qualifying vehicles in the 2012 model year. However, no manufacturers reached the 25,000 vehicle threshold for the 2012 model year. Electric vehicles, fuel cell vehicles, and plug-in hybrid electric vehicles that were included in a manufacturer's calculations of early credits also count against the production limits. As noted in Section 2, both General Motors and Mercedes-Benz selected a path that allows them to carry their 2011 model year production of advanced technology vehicles into the 2012 or later model years, where the low emissions of those vehicles (the Chevrolet Volt, the Mercedes-Benz smart fortwo electric vehicles, and the Mercedes-Benz F-Cell fuel cell vehicle) could help them address an emissions deficit. Neither company used these vehicles in their 2012 fleet average calculations. The use of these vehicles will be noted in a future EPA report for the model year in which they are used.

After a manufacturer reaches the production volume limits they may no longer use zero grams/mile, and must instead account for the net "upstream" emissions associated with their use of grid electricity relative to vehicles powered by gasoline. Based on the GHG emissions from today's national average electricity generation and other key assumptions related to vehicle electricity consumption, vehicle charging losses, and grid transmission losses, a midsize electric vehicle might have upstream GHG emissions of about 180 grams/mile, compared to the upstream GHG emissions of a typical midsize gasoline car of about 60 grams/mile. Thus, the electric vehicle would have a net upstream emissions value of about 120 grams/mile. EPA regulations provide all the information necessary to calculate a unique net upstream value for each electric or plug-in hybrid electric vehicle.

Table 3.4-1. Production Volumes of Advanced Technology Vehicles Using Zero Gram/Mile Incentive, by Model year

Manufacturer	2010	2011	2012	Total
Coda			115	115
Fisker			1,415	1,415
Ford			653	653
General Motors		4,370	18,355	22,725
Mercedes-Benz		1,169	25	1,194
Mitsubishi			1,435	1,435
Nissan		8,495	11,460	19,955
Tesla	599	269	2,952	3,820
Toyota			452	452
Total	**599**	**14,303**	**36,747**	**51,649**

3.5 Methane and Nitrous Oxide Standards

EPA finalized emission standards for methane (CH_4) and nitrous oxide (N_2O) emissions as part of the rule setting the 2012-2016 model year GHG standards. The standards that were set in that rulemaking were 0.010 grams/mile for N_2O and 0.030 grams/mile for CH_4. These standards were established to cap emissions of GHGs, given that current levels are generally significantly below these established standards. These capping standards were intended to prevent future increases in emissions of these GHGs, and were generally not expected to result in the application of new technologies or significant costs for manufacturers using current designs.

There are three different ways for a manufacturer to demonstrate compliance with these standards. First, and used by most manufacturers, manufacturers may demonstrate compliance with these standards with test data as they do for all other non-GHG emission standards. Because there are no credits or deficits involved with this approach, and there are no consequences with respect to the CO_2 fleet average calculation, the manufacturers are not required to submit this data as part of their GHG reporting and hence this GHG compliance report does not include information from manufacturers using this option. Second, as part of the 2012-2016 rulemaking, EPA also finalized an alternative CO_2-equivalent standard option, which manufacturers may choose in lieu of complying with the cap standards. This CO_2-equivalent standard option allows manufacturers to include CH_4 and N_2O, on a CO_2-equivalent basis, in their CO_2 emissions fleet average compliance level. This is done without adjusting the fleet average CO_2 standard to account for the addition of CH_4 and N_2O emissions. Manufacturers that choose this option are required to include the CH_4 and N_2O emissions of all their vehicles for the purpose of calculating their fleet average. In other words, the value of CREE (the carbon-related exhaust emissions, as described earlier) for these manufacturers will include CO_2, hydrocarbons, and carbon monoxide, as well as CH_4 and N_2O emissions, for all their vehicles. Three manufacturers chose to use this approach in the 2012 model year: Mazda, Nissan, and Subaru. For these manufacturers, the calculated fleet average values shown in Table 3.1.1-1 thus include CH_4 and N_2O.

A third alternative to meeting the CH_4 and N_2O standards was initially limited to the 2012-2014 model years, but was subsequently expanded to include all model years of the program. Under this approach, manufacturers can essentially define an alternative, less stringent CH_4 and/or N_2O standard for any vehicle that may have difficulty meeting the specific standards. This alternative standard is treated as any other emission standard in that it must be met for the full useful life of the vehicle. This method provides some additional flexibility relative to the other two options in that (1) a manufacturer can target specific vehicles for alternative standards without incurring a fleet-wide impact, and (2) CH_4 and N_2O are delinked, in that a manufacturer can meet the default regulatory standard for one and select an alternative standard for the other. However, the key aspect of this approach is that manufacturers that use it must calculate a deficit based on the less stringent standards and on the production volumes of the vehicles to which those standards apply. Five manufacturers made use of the flexibility offered by this approach, as shown in Table 3.5-1. Like any other deficit, these deficits must ultimately be offset by CO_2 credits. While these deficits could be carried forward to the next three model years like other deficits, all of the manufacturers using this approach were able to cover these incremental deficits with credits, either carried forward from 2009-2011 or generated in 2012. On an industry-wide basis, the deficits associated with CH_4 and N_2O are relatively small, making up about four percent of the industry-wide accumulated deficits (see Table 3-2).

Table 3.5-1. Reported CH4 and N2O Deficits by Manufacturer and Fleet, 2012 Model Year (Mg)

	Car		Truck			Gram/Mile
Manufacturer	**CH_4**	**N_2O**	**CH_4**	**N_2O**	**Total**	**Equivalent**
BMW	N/A	N/A	(3,944)	(15,671)	(19,615)	(0.4)
Chrysler	(8,804)	N/A	(19,913)	N/A	(28,717)	(0.1)
Ford	(13,440)	(2,714)	(30,401)	(147,158)	(193,713)	(0.5)
General Motors	(28,110)	N/A	(73,522)	N/A	(101,632)	(0.2)
Volkswagen	(56,497)	(138,267)	(1,515)	(16,913)	(213,192)	(1.8)
Total	**(106,851)**	**(140,981)**	**(129,295)**	**(179,742)**	**(556,869)**	**(0.2)**

3.6 2012 Model Year Performance Summary

The complete assessment of a manufacturer's performance in the 2012 model year, before applying early 2009-2011 credits or purchased credits, is represented by the accumulated credits and deficits described in sections 3.1-3.5. It is the cumulative effect of all of these credits and deficits that determines how a manufacturer's 2012 model year car and truck fleets did in comparison to their 2012 car and truck standards. We generally report these credits and deficits in Megagrams, as they are calculated under the regulations, occasionally converting to a gram per mile equivalent. In this section, we exclusively report values in grams per mile, deriving a "final performance value" that can be compared on equal terms with the footprint-based fleet standards.[30] Table 3.6-1 shows the derivation of this final performance value for cars and Table

[30] Note that when EPA established the 2012-2016 standards we projected that manufacturers would use substantial credits from flexible fuel vehicles and air conditioning systems to meet those standards. See 75 FR 25400 (May 7, 2010), where Table III.A.3-2 projects 6.5 grams/mile of FFV credits and 3.5 grams/mile of A/C credits across the

3.6-2 shows the same for trucks, for each manufacturer. The second column of numeric data shows the most basic of values, the starting point for all manufacturers: the fleet average tailpipe CO_2 emissions without any credits applied. The central columns then show the gram/per mile impact of each type of credit or deficit, and finally, the total gram/mile impact of all credits. The two rightmost columns show each manufacturer's final performance value – the starting tailpipe value minus the total of the gram/mile credits – and the applicable footprint-based standard. Note that a calculation of total tons of credits or deficits by using the difference between the final performance value and the standard will yield a value very close to the total tons of credits reported in Table 5-1, but because of the rounding used in transforming credits to grams/mile and the rounding of the values to the nearest gram/mile, the results will not always be in complete agreement.

fleet. Note that Table III.A.3-2 also projects a combined (car plus truck) emissions standard in 2012 of 295 grams/mile (reflecting use of FFV and A/C credits) and that the actual 2012 fleet achieved a lower performance value of 286 grams/mile.

Table 3.6-1. 2012 Model Year Aggregate Performance, Gram/Mile Equivalent - Cars

Manufacturer	Fleet Average Footprint (sq. ft.)	CO_2 Tailpipe, No Credits	Gram/Mile Equivalent of Credits				2012 Model Year	
			FFV	A/C	CH_4 & N_2O	Total of All Credits	Final Performance Value	Standard
BMW	45.9	277		7.1		7.1	270	269
Chrysler	47.2	300	13	9.3	-0.1	22.2	278	277
Coda	41.5	0				0	0	246
Ferrari*	47.8	494		10.0		10.0	484	345
Fisker	58.1	146				0	146	315
Ford	45.3	261	9	3.4	-0.1	12.3	249	265
General Motors	46.9	283	11	7.9	-0.1	18.8	264	272
Honda	45.0	237		3.1		3.1	234	263
Jaguar Land Rover*	51.0	376		4.6		4.6	371	364
Mazda	43.9	241				0	241	259
Mercedes Benz*	46.5	316	11	9.4		20.4	308	277
Mitsubishi	44.5	262				0	262	261
Nissan	45.0	258		2.1		2.1	256	263
Porsche*	44.7	325				0	325	332
Subaru	44.3	257				0	257	260
Suzuki	42.1	267				0	267	251
Tesla[31]	53.6	0		5.7		5.7	0	304
Toyota	45.0	221		7.1		7.1	214	264
Volkswagen	45.0	274	1	6.1	-2.0	5.1	269	263
Volvo	46.8	297		10.5		10.5	286	272
All	**45.6**	**260**	**5**	**5.4**	**-0.2**	**9.8**	**250**	**267**

*These manufacturers are participating in the TLAAS program and are meeting alternative standards for all or a portion of their car fleet, as described in Section 3.1.2. Where these manufacturers have cars in both Primary and TLAAS fleets, for the purpose of this table we have calculated values for the total car fleet by merging values from the Primary and TLAAS fleets, weighted by the production in each fleet.

[31] Tesla exclusively manufactures electric vehicles. Under EPA regulations, the default calculation of emissions for electric vehicles is a non-zero value that accounts for the net upstream emissions of electric power generation relative to the upstream emissions of a gasoline vehicle (see 40 CFR 600.113-12(n)). However, under the temporary incentives in the regulations for electrified vehicles, Tesla and other manufacturers of such vehicles are allowed to use a value of zero grams/mile as long as cumulative production of such vehicles remains below the 200,000 manufacturer-specific vehicle production cap for the 2012-2016 model years. When Tesla's additional air conditioning credits are applied, the methodology described here would indicate a negative emissions performance value, which is counterintuitive. This is an artifact of (1) the temporary incentives established in the regulations, (2) the fact that Tesla makes only electric vehicles, and (3) that Tesla production in model year 2012 remains below the vehicle production cap discussed above. Thus we have set Tesla's performance in this table to zero grams/mile rather than a negative value. This treatment will change if and when electric vehicle production exceeds the vehicle production cap for model years 2012-2016.

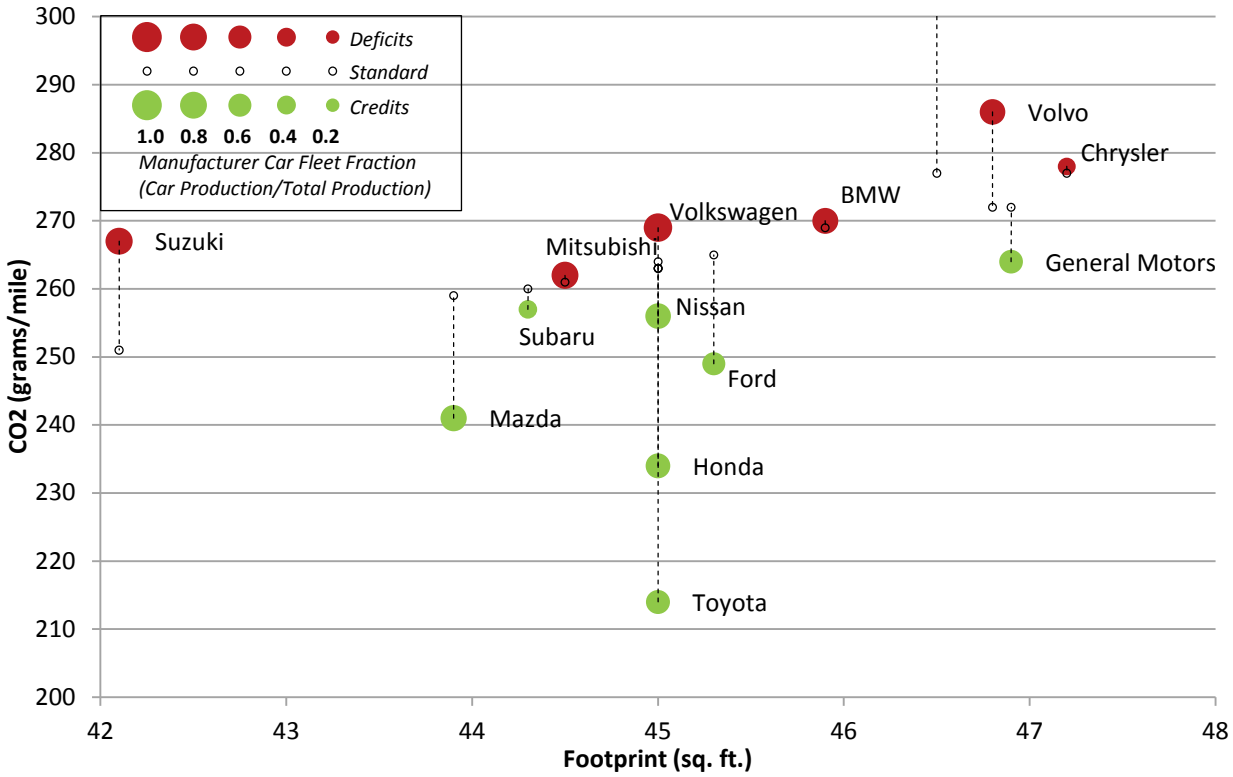
Table 3.6-2. 2012 Model Year Aggregate Performance, Gram/Mile Equivalent - Trucks

Manufacturer*	Fleet Average Footprint (sq. ft.)	CO_2 Tailpipe, No Credits	Gram/Mile Equivalent of Credits				2012 Model Year	
			FFV	A/C	CH_4 & N_2O	Total of All Credits	Final Performance Value	Standard
BMW	51.4	363		11.1	-1.3	9.8	353	336
Chrysler	53.6	384	21	10.0	-0.1	30.9	353	345
Ford	59.4	385	21	7.4	-1.1	27.3	358	364
General Motors	60.1	397	23	8.5	-0.4	31.1	366	369
Honda	50.5	320		4.0		4.0	316	333
Jaguar Land Rover*	48.4	439		8.2		8.2	431	388
Mazda	48.1	324				0	324	323
Mercedes Benz*	51.9	393	15	11.3		26.3	367	360
Mitsubishi	44.0	283				0	283	307
Nissan	51.6	382	15	3.7		18.7	363	337
Porsche*	51.8	362				0	362	422
Subaru	44.7	296				0	296	309
Suzuki	48.7	361				0	361	325
Toyota	53.4	354	9	5.9		14.9	339	342
Volkswagen	49.0	330		9.3	-1.3	8.0	322	327
Volvo	48.6	343		11.8		11.8	331	325
All	**54.6**	**370**	**15**	**7.1**	**-0.3**	**21.6**	**349**	**349**

*These manufacturers are participating in the TLAAS program and are meeting alternative standards for all or a portion of their truck fleet, as described in Section 3.1.2. Where these manufacturers have trucks in both Primary and TLAAS fleets, for the purpose of this table we have calculated values for the total truck fleet by merging values from the Primary and TLAAS fleets, weighted by the production in each fleet.

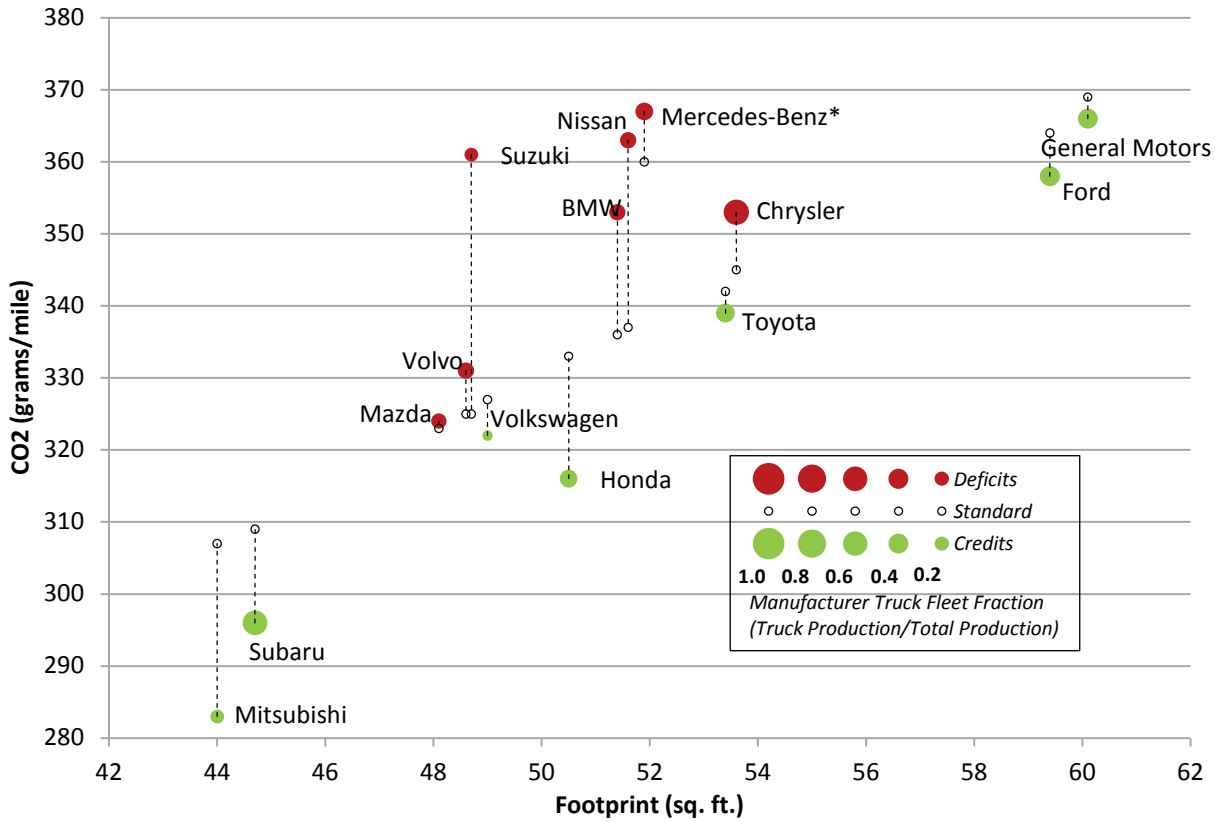
Figures 3.6-1 and 3.6-2 show the final performance values and the standards from the previous tables relative to the fleet average footprint of each manufacturer's car and truck fleets. These figures also add an extra dimension showing the fraction of a manufacturer's fleet that is either cars or trucks, as well as indicating by color whether the manufacturer is accruing credits or deficits in the fleet represented on the figure. To make Figure 3.6-1 more easily legible we have restricted the axes such that manufacturers with very low (Coda, Tesla, Fisker) or very high (Ferrari, Jaguar Land Rover, Porsche) CO_2 values or footprint values are not shown, but all the manufacturer data is included in Table 3.6-1. Similarly, Porsche's high emission standard for trucks results in their exclusion from Figure 3.6-2, but their data is shown in Table 3.6-2.

Figure 3.6-1. 2012 Model Year Performance & Standard by Manufacturer and Average Footprint – Car Fleets



*These manufacturers are participating in the TLAAS program and are meeting alternative standards for all or a portion of their car fleet, as described in Section 3.1.2. Where these manufacturers have cars in both Primary and TLAAS fleets, for the purpose of this chart we have calculated values for the total car fleet by merging values from the Primary and TLAAS fleets, weighted by the production in each fleet.

Figure 3.6-2. 2012 Model Year Performance & Standard by Manufacturer and Average Footprint – Truck Fleets



*These manufacturers are participating in the TLAAS program and are meeting alternative standards for all or a portion of their car fleet, as described in Section 3.1.2. Where these manufacturers have cars in both Primary and TLAAS fleets, for the purpose of this chart we have calculated values for the total car fleet by merging values from the Primary and TLAAS fleets, weighted by the production in each fleet.

4 Credit Transactions

Credits may be traded among manufacturers with a great deal of flexibility (with the exception of 2009 model year credits and credits generated by manufacturers using the TLAAS program, which are restricted to use only within a manufacturer's own fleets). There are only a few regulatory requirements that relate to credit transactions between manufacturers (other than the restrictions just noted), and these are generally designed to protect those involved in these transactions. While it may seem obvious, it is worth stating that a manufacturer may not trade credits that it does not have. Credits that are available for trade are only those available (1) at the conclusion of a model year when all the data is available with which to calculate the number of credits generated by a manufacturer, and not before; and (2) after a manufacturer has offset any deficits they might have. Credit transactions that result in a negative credit balance for the selling manufacturer are not allowed and can result in severe punitive actions. Although a third party may facilitate transactions, EPA's regulations allow only the automobile manufacturers to engage in credit transactions and hold credits.

Since the 1990's, many of EPA's vehicle emissions regulatory programs have included the flexibilities of averaging, banking, and trading (ABT). The incorporation of ABT provisions in EPA emissions regulations has been generally universally supported by a wide range of stakeholders; by manufacturers for the increased flexibility that ABT offers, and by environmental groups because ABT enhances EPA's ability to introduce standards of greater stringency in an earlier time frame than might otherwise be achieved. Historically manufacturers tended to make use of the ability to average emissions and bank emissions credits for use in subsequent years, but until now there has been almost no credit trading activity between companies. The use of trading provisions in EPA's light-duty GHG program is a historic development, and one that EPA welcomes because we believe it will allow greater GHG reductions, lower compliance costs, and greater consumer choice.

The credit transactions reported by manufacturers in their 2012 model year reporting documents are shown in Table 4-1.[32] Credit sales are shown as negative values, in that a sale represents a deduction of credits of the specified model year for the selling manufacturer. Credit purchases are indicated as positive values because buying credits represents an increase in credits for the purchasing manufacturer. The model year represents the "vintage" of the credits that were sold, i.e., the model year from which the credits originated. As noted in Section 2, these transactions are not reflected there or elsewhere in this report because the primary intent of this report is to provide details regarding the credits and deficits generated by manufacturers. The overall impact of these credit transactions on the compliance position of each manufacturer is discussed in Section 5, which pulls together all the credits and deficits that have been discussed in preceding sections. Note that each value in the table may represent multiple transactions.

[32] EPA is aware of additional credit transactions that have occurred, or that are expected to occur, but because of the timing of those transactions (after the manufacturers submitted their 2012 model year data) they will be reported in the 2013 model year reports of the manufacturers involved, and thus will be included in EPA's 2013 model year report.

Table 4-1. Reported Credit Sales and Purchases as of the 2012 Model Year (Mg)

	Manufacturer	Model Year 2010	2011	2012	Total
CREDITS SOLD	Honda	90,000	-	-	90,000
	Nissan	-	500,000	250,000	750,000
	Tesla	35,580	14,192	177,941	227,713
CREDITS PURCHASED	Chrysler	-	500,000	-	500,000
	Ferrari	90,000	-	-	90,000
	Mercedes-Benz	35,580	14,192	427,941	477,713

5 Compliance Status after the 2012 Model Year

There are several important points to make regarding the 2012 model year and the compliance of manufacturers following the 2012 model year, the first year of the EPA GHG program for light-duty vehicles and light-duty trucks. First, readers should avoid making conclusions or projections regarding a manufacturer's status based on this single snapshot of performance. This is the first year of a multi-year fleet-averaging program in which manufacturers are able to carry forward credits and deficits, move credits between their car and truck fleets, buy credits from other manufacturers, and generate several types of additional optional credits. It is possible, for example, for a manufacturer to routinely fall short of meeting the fleet average tailpipe emissions targets yet remain in total compliance with the program. Further, manufacturers are introducing new, more fuel-efficient technologies each year, as we can see already in the 2013 and 2014 model year vehicles that have been introduced following the 2012 model year covered by this report. Second, compliance is based on the total credit picture, as shown in Table 5-1, in which the totality of fleet average credits or deficits, optional credits, and credit transactions is considered.

In this first year, all manufacturers are, by definition, in compliance with the program. This report should be thought of not as a compliance report, since it makes no conclusions regarding compliance or lack thereof. Instead, it should be thought of as a performance report, since it documents the performance of manufacturers as they work towards the long-term goal of complying with EPA's program. For example, while it is fair to say that nine manufacturers were unable to meet their car and/or truck fleet average CO_2 standards applicable in the 2012 model year, this fact in isolation has no meaning with respect to the overall compliance position of these manufacturers. All but one of these manufacturers were able to offset any resulting 2012 model year deficit through GHG reductions achieved through other means and the application of optional credits generated from those reductions. Generating a fleet average tailpipe deficit does not, in and of itself, indicate lack of compliance with EPA's program, which seeks GHG reductions in all aspects of the vehicles. And for the single manufacturer still remaining with a net deficit after accounting for all early and optional credits, a deficit does not necessarily mean lack of compliance with the program. In this first year of the program especially, a deficit does not imply a failure to comply with the program because of the ability to carry a deficit forward for up to three model years after the year in which the deficit was generated.

Table 5-1 shows the net GHG status for each manufacturer as of the completion of the 2012 model year. As noted above, the status as of the 2012 model year can only be determined after assessing everything a manufacturer has done, including participation in the voluntary credit programs and in credit transactions with other manufacturers. All of these elements, which have been detailed in previous sections of this report, are summarized in Table 5-1, in which the right-most column shows the net overall credits for each manufacturer remaining at the end of the 2012 model year. At the end of each model year, all credits and deficits discussed in previous sections of this report are accumulated within each vehicle category (car and truck), as shown for the 2012 model year in Table 5-1. Then, if a deficit is remaining for the model year, the manufacturers must apply available credits to offset that deficit (a deficit may not be carried forward if there are credits available to offset the deficit). Table 5-1 shows the use of early credits and purchased credits to offset 2012 deficits. For example, BMW accumulated total deficits of 291,272 Mg in the 2012 model year. We know, from Table 2-1, that they entered the

2012 model year with 884,903 Mg of early credits. Table 5-1 shows the transfer of 291,272 Mg of those early credits to the 2012 model year to offset the deficit from that model year, leaving BMW with 593,631 Mg of early credits remaining, all of which can be carried over to the 2013 model year.

Note that Table 5-1 is an over-simplification, especially with respect to manufacturers with vehicles in the TLAAS program, in that the credits from all of the fleets are aggregated into one row in the table. However, it does accurately reflect the net credits at the end of the 2012 model year. Ferrari is another case that bears some explanation. As shown in Section 4, Ferrari purchased 90,000 Mg of credits, with a "vintage" of 2010. Ferrari did not generate early credits, but because of the vintage of these purchased credits they appear in the 2009-2011 model year column of the table. Ferrari used 40,893 Mg of these credits to offset their 2012 deficit, leaving 49,017 Mg remaining to carry forward to 2013. Similarly, Chrysler's purchase of 500,000 Mg of credits simply adds to their early credits total because of the vintage of the purchased credits (2010 model year). As the table shows, with one exception, manufacturers ended the 2012 model year with net credits to carry forward to the 2013 model year. Note that the early credits (2009-2011 model years) are shown with less detail than the 2012 model year credits. A detailed breakdown of the early credits was presented in EPA's March 2013 report and is not repeated here. (However, it is important to note that the impacts of transactions involving credits from the early credit years are included in the balances for those model years in Table 5-1.) Note also that for those manufacturers participating in the TLAAS program, as described in Section 3.1.2 of this report, the credits of the Primary and TLAAS fleets are combined in Table 5-1. Although they are not separated for the purposes of Table 5-1, EPA maintains careful records (as do the manufacturers) of the credits within the Primary and TLAAS programs, as is necessary because of the different treatment and restrictions for the different fleets. And the data we are making available with this report will specifically identify the source of each credit (e.g., whether from the Primary or TLAAS fleets). Finally, note that this table does not show the specific activity of transferring credits to offset deficits and the resulting model year credit balances, although these offsetting transactions are implied in the number in the final column. However, especially with future model years in which credits will have differing expiration dates depending on the model year the credits were generated, EPA will maintain a correct accounting not just of the total credits held by a manufacturer, but the model year of origin of each of those credits. Finally, although the sales of credits that were generated in the early model years of 2009-2011 are not specifically shown, their impact on the balances in those early model years is reflected in the values in Table 5-1.

Table 5-1. Cumulative Credit Status by Manufacturer at Conclusion of 2012 Model Year (Mg)

Manufacturer	Early Credits After Trades & Transfers (2009-2011)	2012 Model Year Credits				Total Carried Forward to 2013
		Car	Truck	Traded Credits	Transfer from Early Credits	
BMW	593,631	(35,365)	(255,907)	-	291,272	593,631
Chrysler	7,718,023	(85,312)	(1,806,872)	-	1,892,184	7,718,023
Coda	-	5,524	-	-	-	5,524
Ferrari*	49,017	(40,983)	-	-	40,983	49,017
Fisker	-	46,694	-	-		46,694
Ford	15,296,436	3,345,635	988,316	-		19,630,387
General Motors	24,564,829	2,226,552	645,802	-		27,437,183
Honda	35,425,108	5,959,159	1,892,092	-		43,276,359
Jaguar Land Rover*	-	(18,515)	(405,517)	-		(424,032)
Mazda	5,467,804	749,725	(14,838)	-	14,838	6,217,529
Mercedes-Benz*	-	(618,935)	(129,788)	427,941	428,044	107,262
Mitsubishi	1,439,197	(10,139)	67,976	-	10,139	1,507,173
Nissan	15,662,037	1,239,226	(1,969,163)	(250,000)	1,969,163	16,651,263
Porsche*	-	23,163	175,185	-		198,348
Subaru	5,755,171	62,183	481,133	-		6,298,487
Suzuki	748,951	(78,937)	(48,762)	-	127,699	748,951
Tesla	-	178,517	-	(177,941)		576
Toyota	80,266,189	12,695,585	467,424	-		93,429,198
Volkswagen	5,864,834	(576,571)	74,076	-	576,571	5,938,910
Volvo	565,163	(148,113)	(27,082)	-	175,195	565,163
Total	**199,416,390**	**24,919,093**	**134,075**	**-**	**5,526,088**	**229,985,646**

*These manufacturers are participating in the TLAAS program and are meeting alternative standards for all or a portion of their truck fleet, as described in Section 3.1.2. Where these manufacturers have trucks in both Primary and TLAAS fleets, for the purpose of this table we have calculated values for the total truck fleet by merging values from the Primary and TLAAS fleets, weighted by the production in each fleet.

Volkswagen can be a useful illustrative example of how credits can be transferred, both across vehicle categories and across model years. Volkswagen, as shown in Table 5-1, ends the 2012 model year with net credits in their truck fleet and a net deficit in their car fleet. The regulations allow the two fleets to be treated individually, thus Volkswagen is not required to use their 2012 truck credits to partially offset their 2012 car deficit. Instead, Volkswagen will likely choose to keep those 2012 truck credits and instead offset their car deficit with the oldest credits in their "bank," because those are the credits that will expire first and thus should be used first (2009 credits expire at the end of the 2014 model year, but 2012 credits expire at the end of the 2021 model year, thus the 2012 credits are more valuable than those from 2009, because they can be retained for a longer time). In Volkswagen's case, they have more than enough credits from the 2009 model year (2,243,205 Mg) to offset their 2012 car deficit (576,571 Mg). In this way they retain their more valuable 2012 credits generated by their truck fleet, and going forward to the 2013 model year their available credits to carry forward from the 2009 model year will be reduced by 576,571 Mg (i.e., by the 2012 car deficit). Table 5-2 illustrates the breakdown of credits by model year that Volkswagen will be carrying forward to the 2013 model year (to either use, trade, or continue carrying to 2014). Note that the overall balance is identical to that shown in Table 5-1, but that the credits available to carry forward from each model year is not necessarily equal to the quantity of credits generated in each model year.

Table 5-2. Model Year Makeup of Volkswagen's Total Credit Balance

Model Year	Credits (Mg)
2009	1,666,634
2010	2,811,663
2011	1,386,537
2012	74,076
Total	**5,938,910**

Any manufacturer that concluded the 2012 model year a net deficit after applying early credits and/or credit purchases is required to offset that deficit by the end of the 2015 model year. In future reports such as this one, which EPA intends to issue on an annual basis, readers will be able to see the evolving status of manufacturers and their overall progress towards meeting the requirements of EPA's light-duty vehicle GHG standards.

Appendix: 2012 Model Year Credits and Deficits

Manufacturer	Pathway	Fleet	Credit Type	Fleet Average (g/mi)	Fleet Standard (g/mi)	Production Volume	Credits (Mg)
BMW	Primary	Car	Fleet Average	277	269	191,154	(298,604)
			A/C Leakage			191,101	146,683
			A/C Efficiency			191,154	116,556
		Truck	Fleet Average	363	336	65,856	(401,613)
			A/C Leakage			65,856	101,361
			A/C Efficiency			65,856	63,960
			CH_4 Deficit			11,641	(3,944)
			N_2O Deficit			11,641	(15,671)
Chrysler	Primary	Car	Fleet Average	287	277	538,887	(1,052,252)
			A/C Leakage			536,415	652,554
			A/C Efficiency			536,415	323,190
			CH_4 Deficit			187,106	(8,804)
		Truck	Fleet Average	363	345	994,996	(4,045,226)
			A/C Leakage			994,996	1,748,404
			A/C Efficiency			994,996	509,863
			CH_4 Deficit			427,450	(19,913)
Coda	Primary	Car	Fleet Average	0	246	115	5,524
Ferrari	Primary	Car	Fleet Average	494	276	1,510	(64,277)
			A/C Leakage				1,858
			A/C Efficiency				1,091
Fisker	Primary	Car	Fleet Average	146	315	1,415	46,694
			Advanced Technology			1,415	
Ford	Primary	Car	Fleet Average	252	265	1,052,721	2,672,261
			A/C Leakage			1,052,721	648,752
			A/C Efficiency			197,889	40,776
			Advanced Technology			653	

Manufacturer	Pathway	Fleet	Credit Type	Fleet Average (g/mi)	Fleet Standard (g/mi)	Production Volume	Credits (Mg)
			CH_4 Deficit			174,597	(13,440)
			N_2O Deficit			3,110	(2,714)
		Truck	Fleet Average	364	364	701,602	0
			A/C Leakage			701,602	1,103,803
			A/C Efficiency			437,204	62,072
			CH_4 Deficit			402,710	(30,401)
			N_2O Deficit			145,756	(147,158)
General Motors	Primary	Car	Fleet Average	272	272	1,449,244	0
			A/C Leakage			1,449,244	1,597,485
			A/C Efficiency			1,417,421	652,193
			Advanced Technology			18,355	
			CH_4 Deficit			383,896	(28,110)
			Off-Cycle			17,016	4,984
		Truck	Fleet Average	374	369	915,130	(1,033,479)
			A/C Leakage			915,130	1,474,314
			A/C Efficiency			827,037	277,651
			CH_4 Deficit			515,380	(73,522)
			Off-Cycle			2,176	838
Honda	Primary	Car	Fleet Average	237	263	1,047,165	5,316,314
			A/C Leakage			1,035,238	282,652
			A/C Efficiency			1,046,684	360,193
		Truck	Fleet Average	320	333	493,414	1,448,784
			A/C Leakage			493,414	253,852
			A/C Efficiency			493,414	189,456
Jaguar Land Rover	Primary	Truck	Fleet Average	303	316	9,086	26,679
			A/C Leakage			9,086	12,518
			A/C Efficiency			9,086	7,593
	TLAAS	Car	Fleet Average	376	364	12,769	(29,920)
			A/C Leakage			12,769	6,634
			A/C Efficiency			12,769	4,771

Manufacturer	Pathway	Fleet	Credit Type	Fleet Average (g/mi)	Fleet Standard (g/mi)	Production Volume	Credits (Mg)
		Truck	Fleet Average	477	408	32,706	(509,713)
			A/C Leakage			32,706	27,158
			A/C Efficiency			32,706	30,248
Mazda	Primary	Car	Fleet Average	241	259	213,308	749,725
		Truck	Fleet Average	324	323	65,696	(14,838)
Mercedes-Benz	Primary	Car	Fleet Average	298	271	163,247	(860,659)
			A/C Leakage				139,794
			A/C Efficiency				167,018
			Advanced Technology			50	
		Transfer	Transfer				427,941
		Truck	Fleet Average	368	335	61,343	(457,223)
			A/C Leakage				97,267
			A/C Efficiency				65,016
	TLAAS	Car	Fleet Average	406	368	10,585	(78,541)
			A/C Leakage				4,587
			A/C Efficiency				8,866
		Truck	Fleet Average	408	434	20,230	118,800
			A/C Leakage				28,291
			A/C Efficiency				18,061
Mitsubishi	Primary	Car	Fleet Average	262	261	51,927	(10,139)
			Advanced Technology			1,435	
		Truck	Fleet Average	283	307	12,540	67,976
Nissan	Primary	Car	Fleet Average	258	263	896,278	875,054
			A/C Leakage			287,947	37,027
			A/C Efficiency			896,278	327,145
			Advanced Technology			11,460	
		Transfer	Transfer				(250,000)
		Truck	Fleet Average	367	337	331,886	(2,248,843)
			A/C Leakage			257,063	147,882
			A/C Efficiency			331,769	131,798

Manufacturer	Pathway	Fleet	Credit Type	Fleet Average (g/mi)	Fleet Standard (g/mi)	Production Volume	Credits (Mg)
Porsche	TLAAS	Car	Fleet Average	325	332	16,946	23,163
		Truck	Fleet Average	362	422	12,927	175,185
Subaru	Primary	Car	Fleet Average	257	260	106,152	62,183
		Truck	Fleet Average	296	309	163,860	481,133
Suzuki	Primary	Car	Fleet Average	267	251	25,266	(78,937)
		Truck	Fleet Average	361	325	5,997	(48,762)
Tesla	Primary	Car	Fleet Average	0	304	2,952	175,231
			A/C Efficiency			2,952	3,286
			Advanced Technology			2,952	
		Transfer	Transfer				(177,941)
Toyota	Primary	Car	Fleet Average	221	264	1,298,021	10,898,641
			A/C Leakage				872,335
			A/C Efficiency				924,609
			Advanced Technology			452	
		Truck	Fleet Average	345	342	722,227	(489,377)
			A/C Leakage				553,633
			A/C Efficiency				403,168
Volkswagen	Primary	Car	Fleet Average	273	263	500,690	(977,667)
			A/C Leakage				221,065
			A/C Efficiency				374,795
			CH_4 Deficit				(56,497)
			N_2O Deficit				(138,267)
		Truck	Fleet Average	330	327	64,882	(43,964)
			A/C Leakage				59,108
			A/C Efficiency				77,360
			CH_4 Deficit				(1,515)
			N_2O Deficit				(16,913)
Volvo	Primary	Car	Fleet Average	297	272	52,375	(255,674)
			A/C Leakage			52,375	64,281

Manufacturer	Pathway	Fleet	Credit Type	Fleet Average (g/mi)	Fleet Standard (g/mi)	Production Volume	Credits (Mg)
			A/C Efficiency			52,375	43,280
		Truck	Fleet Average	343	325	19,432	(79,002)
			A/C Leakage			19,432	33,040
			A/C Efficiency			19,432	18,880