

The

2019

**EPA Automotive
Trends Report** _____

Greenhouse Gas Emissions,
Fuel Economy, and
Technology since 1975



Executive Summary

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This annual report is part of the U.S. Environmental Protection Agency's (EPA) commitment to provide the public with information about new light-duty vehicle greenhouse gas (GHG) emissions, fuel economy, technology data, and auto manufacturers' performance in meeting the agency's GHG emissions standards.

EPA has collected data on every new light-duty vehicle model sold in the United States since 1975, either from testing performed by EPA at the National Vehicle and Fuel Emissions Laboratory in Ann Arbor, Michigan, or directly from manufacturers using official EPA test procedures. These data are collected to support several important national programs, including EPA criteria pollutant and GHG standards, the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) Corporate Average Fuel Economy (CAFE) standards, and vehicle Fuel Economy and Environment labels. This expansive data set allows EPA to provide a uniquely comprehensive analysis of the automotive industry over the last 40 plus years.

All data in this report for model years 1975 through 2018 are **final** and based on official data submitted to EPA and NHTSA as part of the regulatory process. In some cases, this report will show data for model year 2019, which are **preliminary** and based on data provided to EPA by automakers prior to the model year. Preliminary data is not shown for manufacturer compliance. The report does not examine future model years, and past performance does not necessarily predict future industry trends.

The carbon dioxide (CO₂) emissions and fuel economy data in this report fall into one of two categories. The first is **compliance** data, which is measured using laboratory tests required by law for CAFE and adopted by EPA for GHG compliance. The second is **estimated real-world** data, which is measured using additional laboratory tests to capture a wider range of operating conditions (including hot/cold weather and higher acceleration) that an average driver will encounter. This report will show estimated real-world data except for the discussion specific to the GHG regulations around Figures ES-6 through ES-8 and in Section 5.

The content in this report was previously published in two separate reports, the *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends Report*, and the *GHG Manufacturer Performance Report*. These reports were combined, starting with the 2018 report, to provide a more comprehensive analysis.

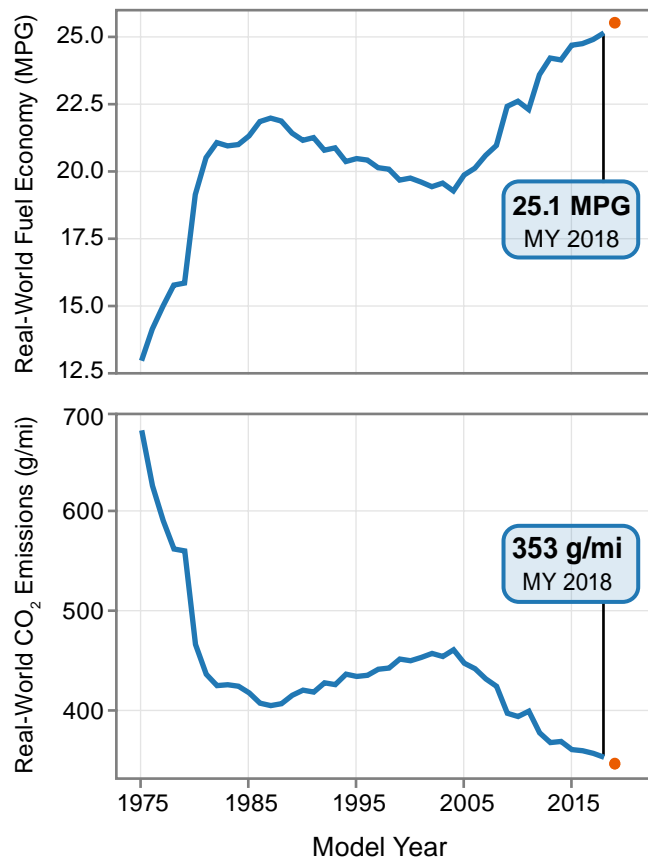
New vehicle estimated real-world CO₂ emissions are at a record low and fuel economy is at a record high

In model year 2018, the average estimated real-world CO₂ emission rate for all new vehicles fell by 4 grams per mile (g/mi) to 353 g/mi, the lowest level ever measured. Fuel economy increased by 0.2 miles per gallon to 25.1 mpg, achieving a record high.

Since 2004, CO₂ emissions have decreased 23%, or 108 g/mi, and fuel economy has increased 30%, or 5.8 mpg. Over that time, CO₂ emissions and fuel economy have improved in twelve out of fourteen years and have repeatedly achieved new records. The trends in CO₂ emissions and fuel economy since 1975 are shown in Figure ES-1.

Preliminary data suggest further improvements in model year 2019. Average estimated real-world CO₂ emissions are projected to fall 6 g/mi to 346 g/mi and fuel economy is projected to increase 0.4 mpg to 25.5 mpg. Projected data are shown in Figure ES-1 as a red dot because the values are based on manufacturer projections rather than final data.

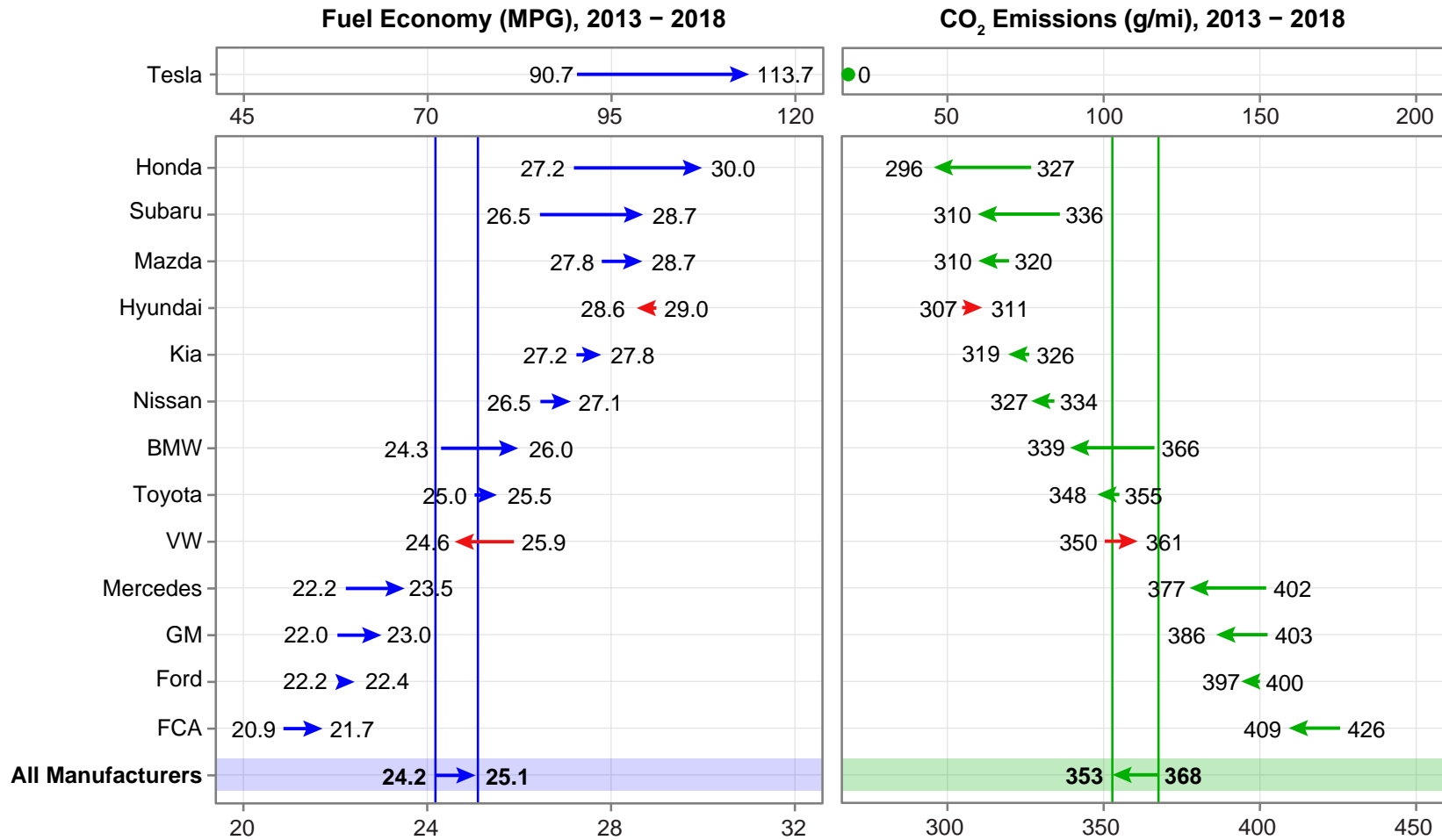
Figure ES-1. Estimated Real-World CO₂ and Fuel Economy



Manufacturers have made significant improvements in fuel economy and CO₂ emissions over the last 5 years

Over the last five years, eleven of the fourteen largest manufacturers selling vehicles in the U.S. market improved both estimated real-world CO₂ emissions and fuel economy of their new vehicle fleets. One manufacturer, Tesla, improved fuel economy (as measured in miles per gallon of gasoline equivalent, or mpge) but not tailpipe CO₂ emissions, because their all-electric fleet produces no tailpipe CO₂ emissions. Two of the fourteen manufacturers increased CO₂ emissions and decreased fuel economy of their new vehicle fleets.

Figure ES-2. Changes in Estimated Real-World Fuel Economy and CO₂ for Large Manufacturers



The five-year span shown in Figure ES-2 covers the approximate length of a vehicle re-design cycle. It is likely that most vehicles have undergone design changes in this period, resulting in a more accurate depiction of recent manufacturer trends than focusing on a single year. The trends shown in Figure ES-2 are due to a combination of vehicle design changes and changes to the distribution of vehicles produced.

Many tables in this report show only manufacturers that produced more than 150,000 vehicles in the last model year. This year, Tesla crossed that threshold and is now shown along with the thirteen large manufacturers in last year's edition of this report. Since Tesla produces only electric vehicles, they had by far the lowest tailpipe CO₂ emissions, at 0 g/mi, and highest fuel economy, at 113.7 mpg, of all large manufacturers in model year 2018.

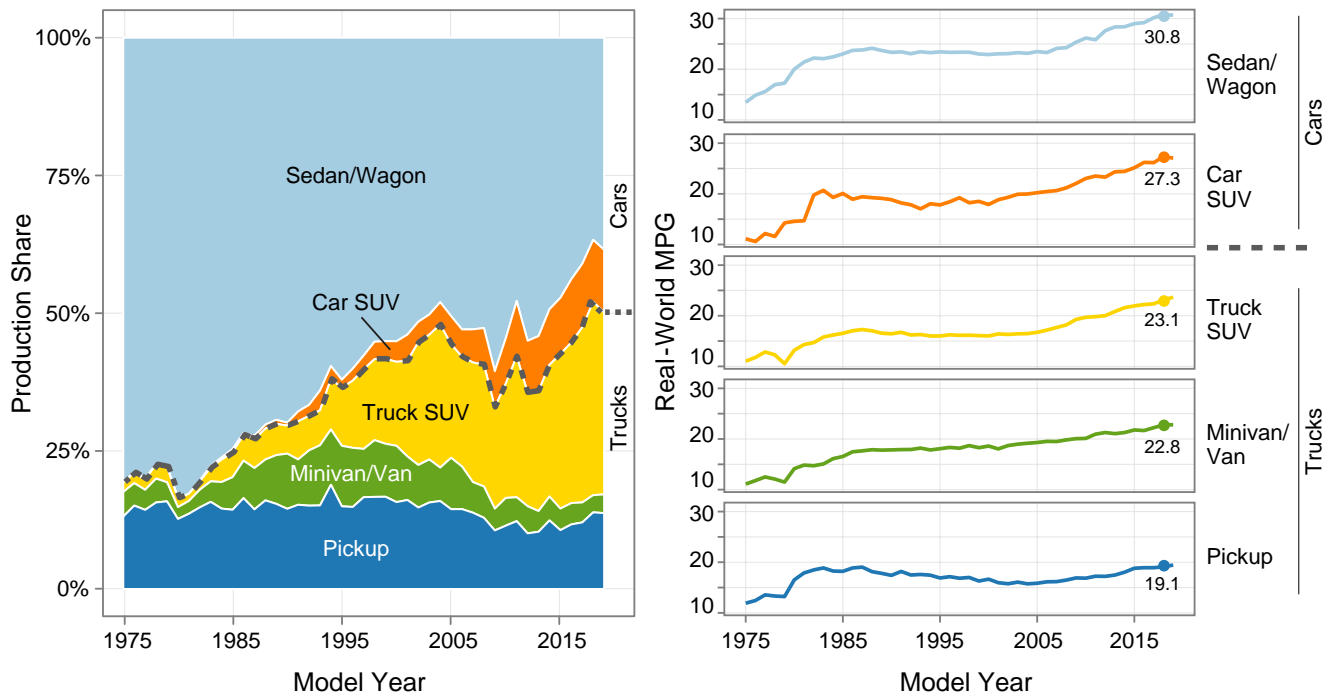
Of the remaining manufacturers, Honda had the lowest CO₂ emissions and highest fuel economy in model year 2018 and also achieved the largest 5-year improvements in CO₂ emissions and fuel economy. Between model years 2013 and 2018, Honda reduced CO₂ emissions by 31 g/mi and increased fuel economy by 2.8 mpg. Subaru and Mazda tied for the third lowest CO₂ emissions and third highest fuel economy in model year 2018. BMW had the second largest 5-year improvement in CO₂ emissions, reducing emissions by 27 g/mi, and Subaru had the third largest improvement, at 26 g/mi. BMW also increased fuel economy by 1.7 mpg, while Subaru increased by 2.2 mpg.

Two manufacturers increased CO₂ emissions and reduced average fuel economy over the five-year span. Volkswagen had the largest increase in CO₂ emissions, at 11 g/mi, and the largest decrease in fuel economy, at 1.3 mpg, due mostly to a large shift towards SUVs. FCA had the highest new vehicle average CO₂ emissions and lowest fuel economy of the large manufacturers in model year 2018, followed by Ford and GM.

Sport utility vehicles continue to gain market share, with all vehicle types achieving record low CO₂ emissions and record high fuel economy

In this report, vehicles are disaggregated into five vehicle types: sedan/wagon, car SUV, truck SUV, pickup truck, and minivan/van. Car SUVs are generally smaller 2WD SUVs while truck SUVs are larger or 4WD vehicles. The distinction between car and truck SUVs is based on regulatory definitions and is important because cars and trucks are subject to different GHG and fuel economy standards. Sedan/wagons and car SUVs are subject to the car regulatory standards while truck SUVs, pickups, and minivans/vans are subject to the truck standards. Note that media reports generally consider all SUVs as trucks, which is different from the regulatory distinctions used in this report.

Figure ES-3. Production Share and Fuel Economy by Vehicle Type



The overall market continues to move towards both car SUVs and truck SUVs. Combined, car and truck SUVs captured a record high 46% market share in model year 2018. Truck SUVs improved fuel economy by 0.8 mpg and CO₂ emissions by 14 g/mile in model year 2018, while car SUVs improved fuel economy by 1.2 mpg and CO₂ emissions by 15 g/mile. Sedan/wagons fell to 37% of the market, or less than half of the market share they held in model year 1975, even as their fuel economy increased by 0.6 mpg.

All five vehicle types are at record low CO₂ emissions and record high fuel economy and have steadily improved in recent years. However, the market shift towards SUVs and away from sedan/wagons has offset some of the fleetwide benefits that otherwise would have been achieved from the increased fuel economy within each vehicle type.

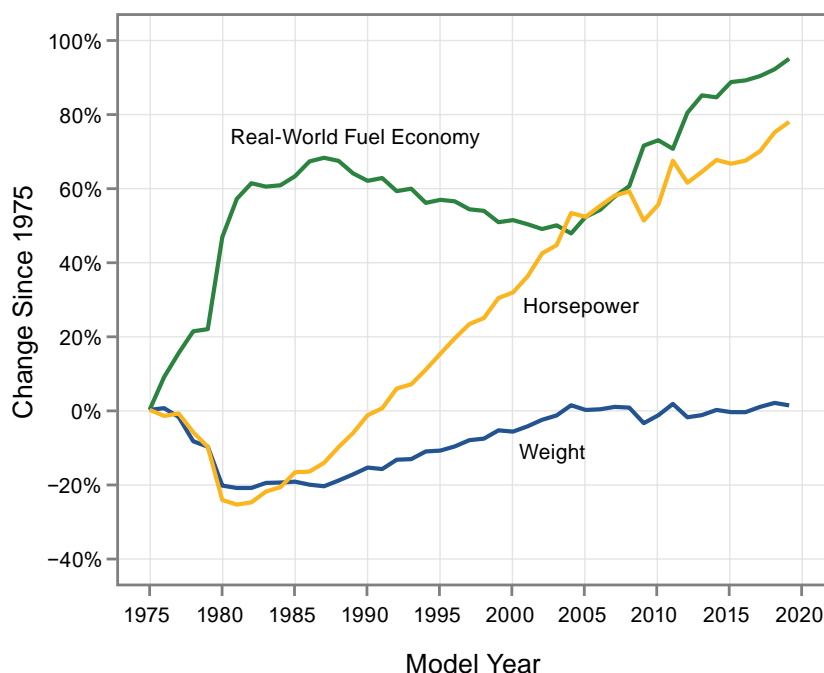
Average new vehicle fuel economy and horsepower continue to increase, while weight remains constant

Vehicle weight and horsepower are two fundamental vehicle attributes that can influence a vehicle's CO₂ emissions and fuel economy. For vehicles with internal combustion engines, increased weight or horsepower generally results in higher CO₂ emissions and lower fuel economy. Weight is also an important metric for electric vehicles, as increased vehicle weight will generally result in lower fuel economy (measured in miles per gallon of gasoline equivalent). However, electric vehicles will produce zero tailpipe emissions regardless of weight or horsepower.

Over time, automotive technology innovation has been applied to vehicle design with differing emphasis between vehicle weight, power, CO₂ emissions and fuel economy (Figure ES-4). In the two decades before model year 2004, technology innovation was generally used to increase vehicle power, and weight increased due to changing vehicle design, increased vehicle size, and increased content. During this period, average new vehicle fuel economy steadily decreased and CO₂ emissions correspondingly increased. However, since model year 2004 technology has been used to increase fuel economy (up 30%) and power (up 14%), while maintaining vehicle weight and reducing CO₂ emissions (down 23%). Weight has generally been constant since 2004, but the slight increase in model year 2018 did result in the highest average new vehicle weight on record.

One additional vehicle metric not shown in Figure ES-4 is vehicle footprint, or the area enclosed by the four tires. Footprint is important because it is the basis for determining regulatory standards under the GHG and CAFE regulations. Since EPA began tracking footprint in model year 2008, average footprint has increased about 3%.

Figure ES-4. Estimated Real-World Fuel Economy, Horsepower, and Weight Since Model Year 1975



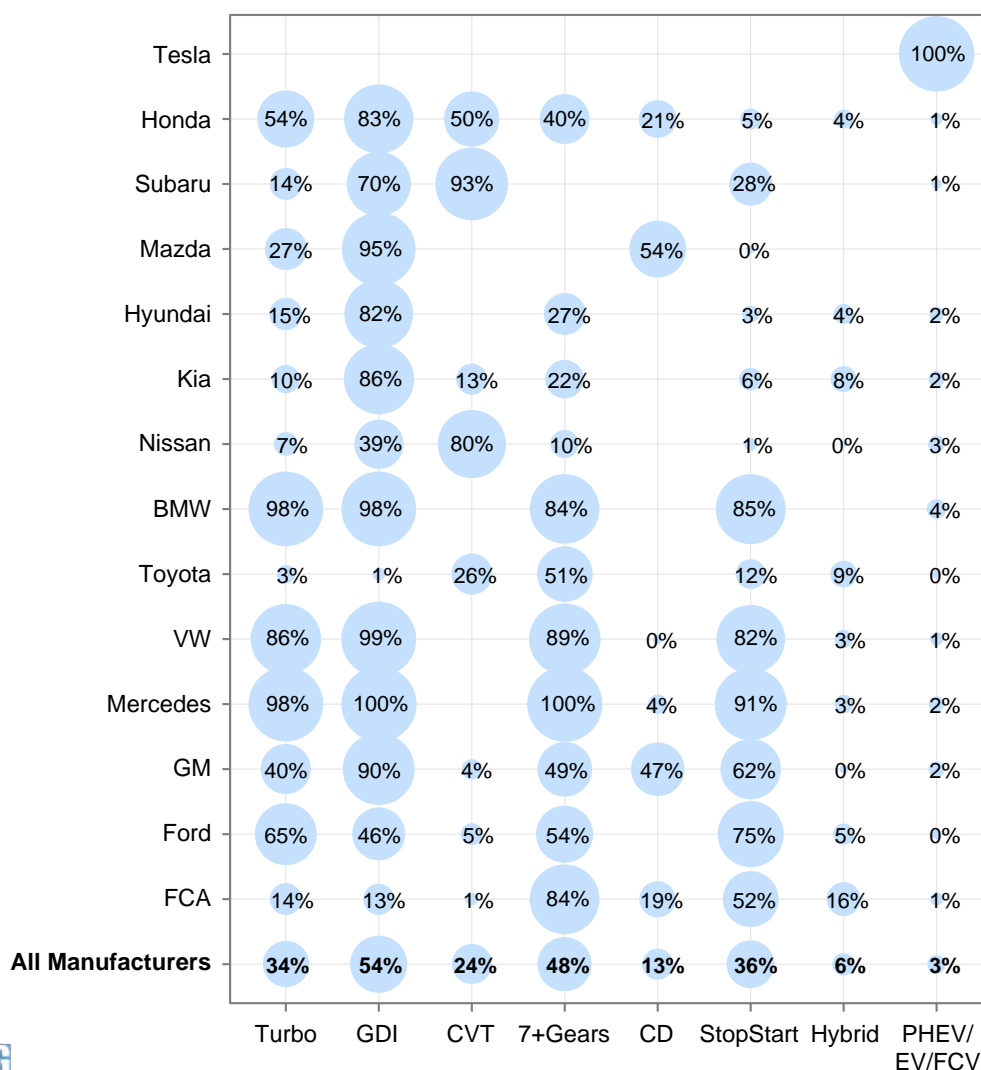
Manufacturers continue to adopt a wide array of advanced technologies

Technological innovation in the automobile industry has led to a wide array of technology available to manufacturers to achieve CO₂ emissions, fuel economy, and performance goals. Figure ES-5 illustrates projected manufacturer-specific technology adoption, with larger circles representing higher adoption rates, for model year 2019. The figure shows preliminary model year 2019 technology projections to provide insight on a quickly changing industry, even though there is some uncertainty in the preliminary data.

Engine technologies such as turbocharged engines (Turbo) and gasoline direct injection (GDI) allow for more efficient engine design and operation. Cylinder deactivation (CD) allows for use of only a portion of the engine when less power is needed, while stop/start systems can turn off the engine entirely at idle to save fuel. Hybrid vehicles use a larger battery to recapture braking energy and provide power when necessary, allowing for a smaller, more efficiently-operated engine. Transmissions that have more gear ratios, or speeds, allow the engine to more frequently operate near peak efficiency. Two categories of advanced transmissions are shown in Figure ES-5: transmission with seven or more discrete speeds (7+ Gears), and continuously variable transmissions (CVTs).

The technologies in Figure ES-5 are all being adopted by manufacturers to reduce CO₂ emissions and increase fuel economy, in some cases quite rapidly. For example, GDI was used in fewer than 3% of vehicles as recently as model year 2008 but is projected to be in more than 50% of vehicles in model year 2019. Electric vehicles (EVs), plug-in hybrid vehicles (PHEVs), and fuel cell vehicles (FCVs) are a small but growing percentage of new vehicles.

Figure ES-5. Technology Share for Large Manufacturers, Model Year 2019

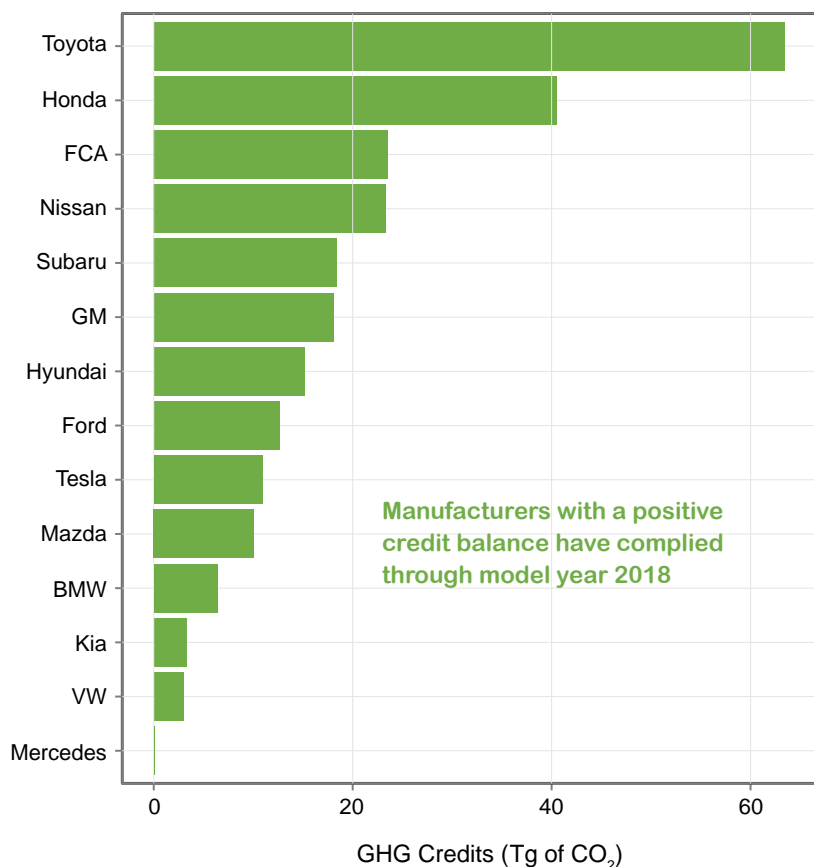


All fourteen large manufacturers achieved compliance with the GHG standards through the 2018 model year

EPA's GHG program is an averaging, banking, and trading (ABT) program. An ABT program means that the standards may be met on a fleet **average** basis, manufacturers may earn and **bank** credits to use later, and manufacturers may **trade** credits with other manufacturers. This provides manufacturers flexibility in meeting the standards while accounting for vehicle design cycles, introduction rates of new technologies and emission improvements, and evolving consumer preferences.

Manufacturers with average fleet emissions lower than the emissions standard generate credits by over complying with the standards. Because credits may not be carried forward unless deficits from all prior model years have been resolved, a positive credit balance means compliance with the current and all previous model years of the program. Any manufacturer with a deficit at the end of the model year has up to three years to offset the deficit with credits generated by future improvements beyond the standards or credits purchased from another manufacturer.

Figure ES-6. GHG Credit Balance for Large Manufacturers, After 2018 Model Year



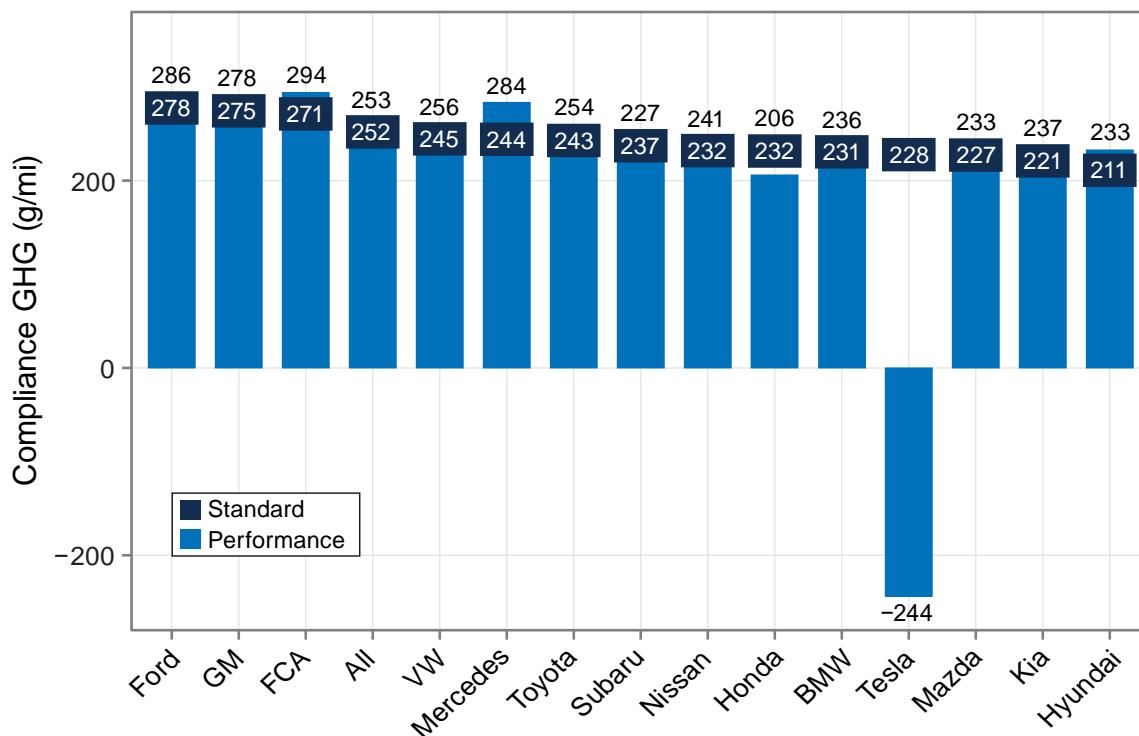
All the large manufacturers (with production of more than 150,000 in model year 2018) ended the 2018 model year with a positive credit balance and are thus in compliance with model year 2018 and all previous years of the GHG program. The accumulated credits shown in Figure ES-6 will be carried forward for use in future model years. Total credits are shown in **teragrams** (one billion kilograms), which accounts for manufacturer performance compared to their standards, expected vehicle lifetime miles driven, and the number of vehicles produced by each manufacturer, for all years of the GHG program.

Manufacturers used different combinations of technology improvements and banked credits to achieve compliance in 2018

Overall, the industry was within 1 gram/mile of complying with the standards without using banked credits. Individual manufacturers however, used different strategies to maintain compliance in model year 2018. Three large manufacturers achieved compliance based on the emission performance of their vehicles, without utilizing additional banked credits. Most other large manufacturers used banked or purchased credits, along with technology improvements, to demonstrate compliance in model year 2018.

Figure ES-7 illustrates the performance of individual large manufacturers in model year 2018 compared to their overall standard, in terms of an average vehicle grams per mile emission rate. This “snapshot” provides insight into how the large manufacturers performed against the standards in model year 2018, but it does not account for banked credits or credit transactions between companies. Thus, Figure ES-7 does not reflect that each of these manufacturers ultimately complied with the model year 2018 standards.

Figure ES-7. Performance and Standards by Manufacturer, 2018 Model Year



The regulations include an “incentive multiplier” for certain technologies for the 2017-2021 model years. This multiplier allowed each 2018 model year electric vehicle to be counted as two. The impact of the incentive is particularly evident for Tesla because they produce only electric vehicles with 0 g/mi tailpipe emissions. Tesla’s standard was 228 g/mi, so on average each Tesla vehicle creates 228 g/mi of credits (plus 16 g/mi of air conditioning and off-cycle credits) before including the multiplier. The incentive multiplier doubles those credits, resulting in an effective performance value of -244 grams/mile, as shown in Figure ES-7.

The manufacturers with emissions above their standards (i.e., generating a 2018 model year deficit) used banked or purchased credits to achieve compliance in model year 2018. All these manufacturers had credits available from previous years, and/or they were able to purchase credits to ensure their credit balance remained positive after model year 2018.

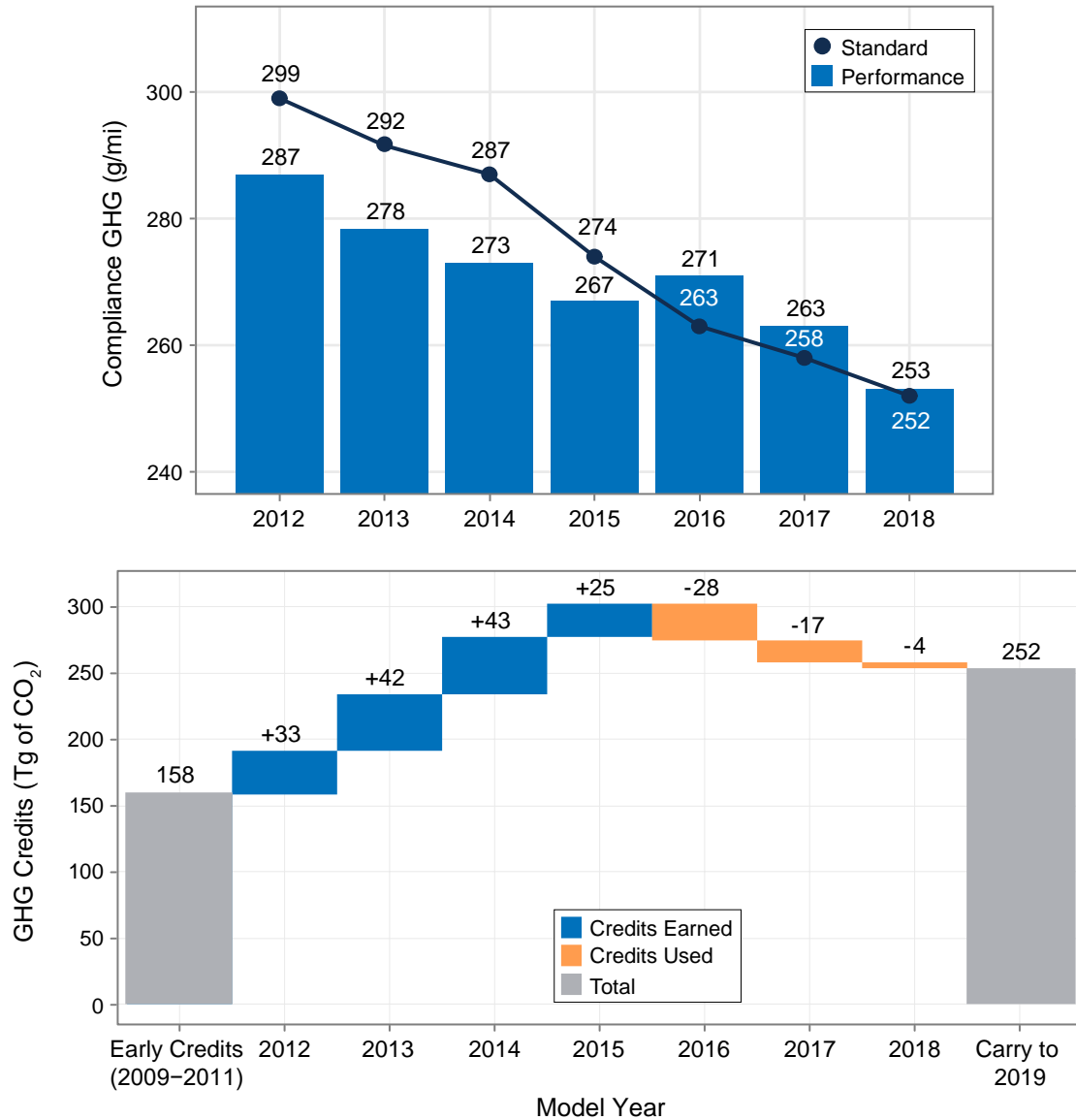
The industry generated almost as many credits as it used in 2018, maintaining a large bank of credits for future model years

The industry emerged from model year 2018 with a bank of more than 250 teragrams (Tg) of GHG credits, as seen in Figure ES-8. Based on their compliance strategy, many manufacturers used credits in model year 2018, but far fewer credits than in the previous two model years. As a result, to maintain compliance the industry depleted their collective credit bank by about 4 Tg, or less than 2% of the total available credit balance. In addition to the balance of the industry-wide bank, the expiration date and distribution of credits are also important factors. Credits earned in model year 2017 or beyond have a five-year life, while all prior credits (78% of the current bank) will expire at the end of model year 2021. At the present time, an active credit market is enabling manufacturers to purchase credits to demonstrate compliance, although the availability of current or future credits is inherently uncertain.

The industry was able to accrue credits before the standards took effect in model year 2012 for early deployment of efficient vehicles and technology (the “early credit” program). The industry generated additional credits the first four years of the program, as the industry GHG performance was below the standards. In the last three years, the industry GHG performance has been above the standards, resulting in withdrawals from the bank of credits to maintain compliance.

In model year 2018, the industry improved overall compliance GHG performance by 10 g/mi. While this was not enough to meet the standard, the gap between the standard and GHG performance narrowed to 1 g/mi from 5 g/mi. Improving vehicle GHG emissions, as well as the electric vehicle incentive multiplier, led to this industry-wide improvement.

Figure ES-8. Industry Performance and Standards, Credit Generation and Use



The automobile industry continues to innovate, improve, and meet the GHG standards

The analysis here is a snapshot of the data collected by EPA in support of several important regulatory programs and is presented with the intent of providing as much transparency to the public as possible. The data show the change and innovation in the industry since model year 1975, and the manufacturers' performance under EPA's GHG standards.

To download the full report, or to explore the data using EPA's new interactive data tools, visit the report webpage at www.epa.gov/automotive-trends.

NOTICE: This technical report does not necessarily represent final EPA decisions, positions, or approval or validation of compliance data reported to EPA by manufacturers. It is intended to present technical analysis of issues using data that are currently available and that may be subject to change. The purpose of the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.

These data reflect the most current available data. Historic data have been adjusted, when appropriate, to reflect the result of compliance investigations by EPA or any other corrections necessary to maintain data integrity. This edition of the report supersedes all previous versions.