The 2021 EPA Automotive Trends Report

Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975

MPG
CO_2

Executive Summary

EPA United States Environmental Protection Agency

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Executive Summary

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 45 years.

The carbon dioxide (CO_2) emissions and fuel economy data in this report fall into one of two categories. The first is **compliance** data, which are measured using laboratory tests required by law for CAFE and adopted by EPA for GHG compliance. The second is **estimated real-world** data, which are measured using additional laboratory tests to capture a wider range of operating conditions (including hot and cold weather, higher speeds, and faster accelerations) encountered by an average driver. This report shows real-world data, except for discussions specific to GHG compliance on pages ES-9 to ES-12 in this summary and Section 5 of the report.

All data in this report for model years 1975 through 2020 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 2021, which are **preliminary** and based on data provided to EPA by automakers prior to the model year, including projected production volumes. Given the impacts of COVID-19 and worldwide supply chain issues, and their associated impacts on the automobile industry, the projected model year 2021 data may change significantly before being finalized.

This report reflects the current light-duty GHG and fuel economy regulations as finalized by EPA and NHTSA. In August 2021, EPA and NHTSA proposed rules to revise the existing light-duty GHG and fuel economy standards for model years 2023–2026 and 2024–2026, respectively. Since these proposals have not been finalized, they are not reflected in this report. Any applicable regulatory changes finalized by EPA and NHTSA will be included in future versions of this report. To download the full report, or to explore the data using EPA's interactive data tools, visit the report website at www.epa.gov/automotive-trends.

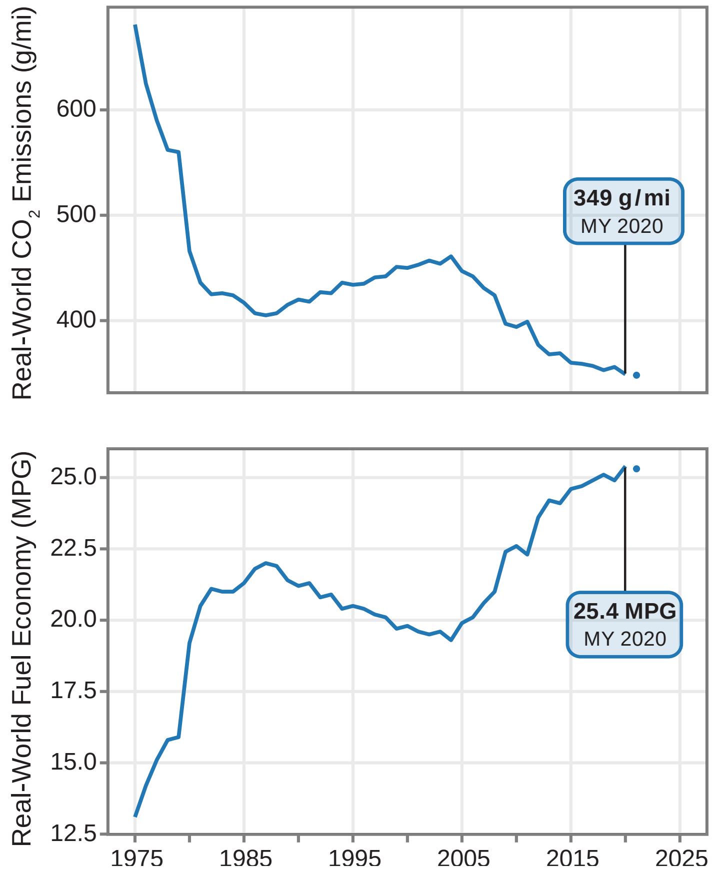
New vehicle estimated real-world CO_2 emissions are at a record low and fuel economy is at a record high

In model year 2020, the average estimated real-world CO_2 emission rate for all new vehicles fell by 7 g/mi to 349 g/mi, the lowest ever measured. Fuel economy increased by 0.5 mpg to 25.4, achieving a record high.

Since model year 2004, CO_2 emissions have decreased 24%, or 112 g/mi, and fuel economy has increased 32%, or 6.1 mpg. Over that time, CO_2 emissions and fuel economy have improved in thirteen out of sixteen years. The trends inCO_2 emissions and fuel economy since 1975 are shown in Figure ES-1.

Preliminary data suggest that CO_2 emissions and fuel economy in model year 2021 will remain near the levels achieved in 2020. These data are shown in Figure ES-1 as a dot because the values are based on manufacturer projections rather than final data.

Figure ES-1. Estimated Real-World Fuel Economy and CO_2 Emissions

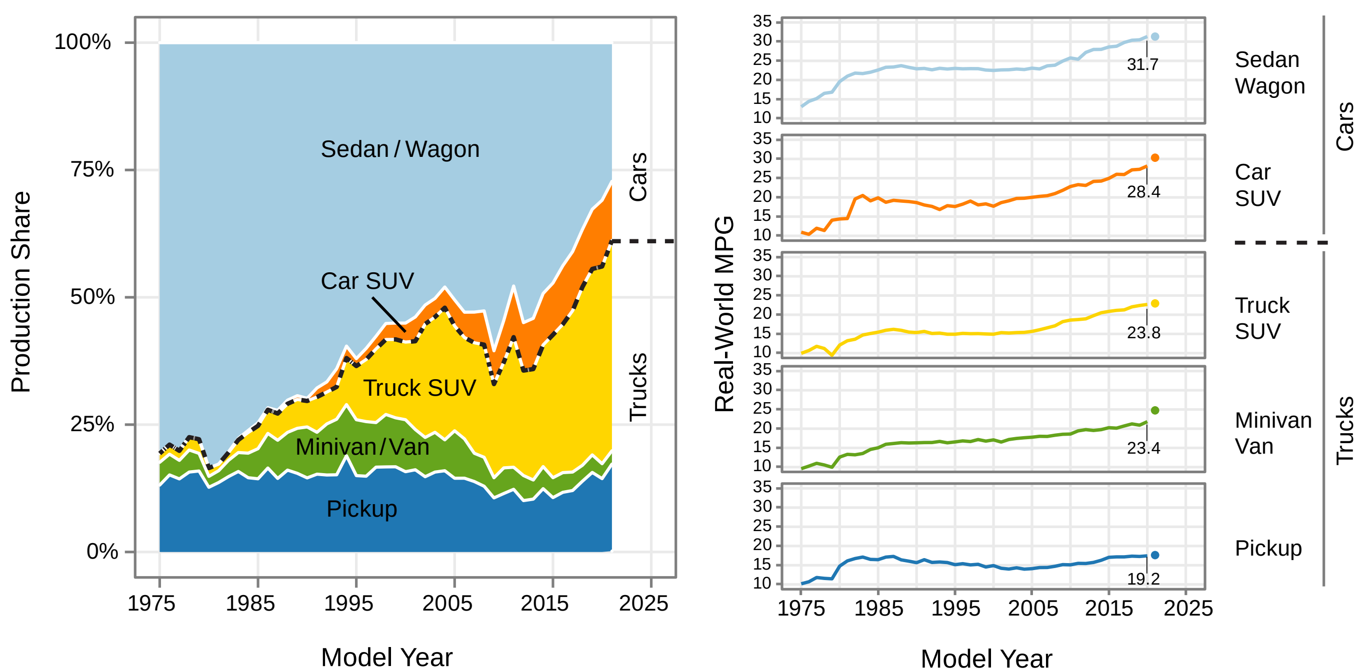


All vehicle types are at record low CO_2 emissions; however, market shifts away from cars and towards sport utility vehicles (SUVs) and pickups have offset some of the fleetwide benefits

In this report, vehicles are disaggregated into five vehicle types: sedan/wagon, car SUV, truck SUV, pickup truck, and minivan/van. The distinction between car and truck SUVs is based on regulatory definitions where SUVs that are 4WD or above a weight threshold (6,000 pounds gross vehicle weight) are generally regulated as trucks and classified at truck SUVs for this report. The remaining 2WD SUVs are subject to car standards and classified as car SUVs. All five vehicle types are at record high fuel economy and record low CO_2 emissions in model year 2020. Minivan/Vans, car SUVs, and sedan/wagons all increased fuel economy by 0.9 mpg, while truck SUVs increased by 0.3 mpg, and pickups increased by 0.2 mpg.

The overall new vehicle market continues to move away from the sedan/wagon vehicle type towards a combination of truck SUVs and car SUVs. Sedans and wagons fell to 31% of the market, well below the 50% market share they held as recently as model year 2013, and far below the 80% market share they held in 1975. Conversely, truck SUVs reached a record 39% of the market in model year 2020, and car SUVs reached a record 13% of the market. The trend away from sedan/wagons, which remain the vehicle type with the highest fuel economy and lowest CO_2 emissions, and towards vehicle types with lower fuel economy and higher CO_2 emissions has offset some of the fleetwide benefits that otherwise would have been achieved from the improvements within each vehicle type.

Figure ES-2. Production Share and Fuel Economy by Vehicle Type

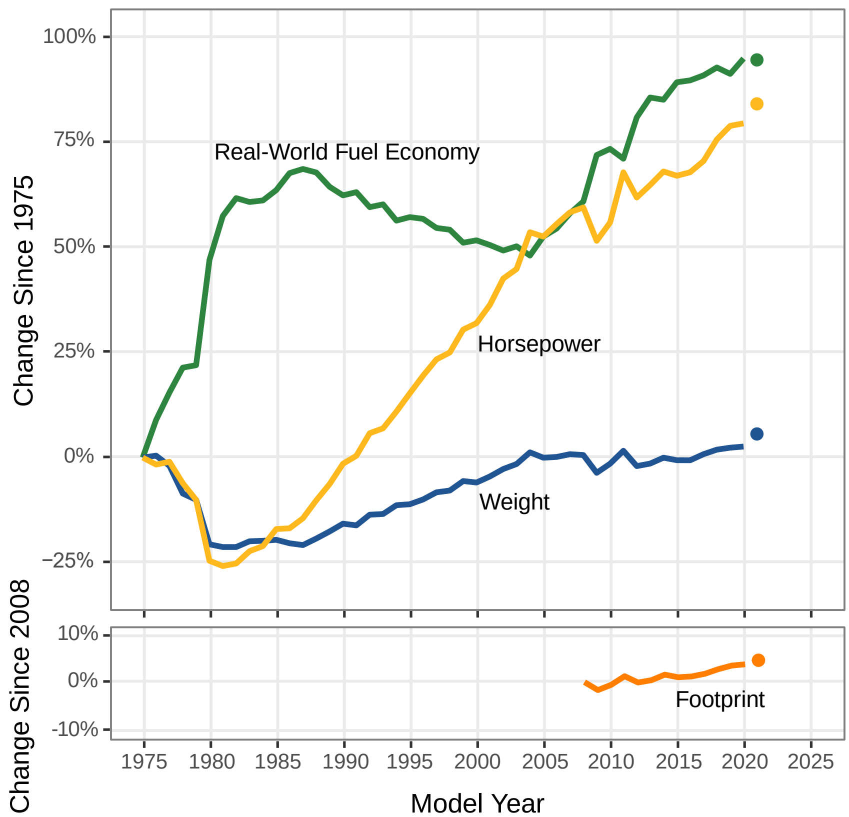


Average new vehicle fuel economy, horsepower, weight, and footprint are all at record highs

Overall vehicle trends are influenced both by vehicle technology and design, and by the changes in the distribution of vehicles being produced. For a specific vehicle, increased weight or horsepower is likely to result in higher CO_2 emissions and lower fuel economy, all else being equal. Larger vehicles, in this case measured by footprint or the area enclosed by the four tires, also tend to have higher CO_2 emissions and lower fuel economy. Footprint is also the basis for determining regulatory standards under the GHG and CAFE regulations. Electric vehicles produce zero tailpipe emissions; however, weight, horsepower, and vehicle size can still impact the vehicle fuel economy (as measured in miles per gallon of gasoline equivalent).

In the two decades prior to 2004, technology innovation and market trends generally resulted in increased vehicle power and weight (due to increasing vehicle size and content) while average new vehicle fuel economy steadily decreased and CO_2 emissions correspondingly increased. Since model year 2004, the combination of technology innovation and market trends have resulted in average new vehicle fuel economy increasing 32%, horsepower increasing 17%, and weight increasing 1%. Footprint has increased 4% since EPA began tracking it in model year 2008. These metrics are all at record highs, and horsepower, weight, and footprint are projected to increase again in model year 2021, as shown in Figure ES-3.

Figure ES-3. Percent Change in Real-World Fuel Economy, Horsepower, Weight, and Footprint



Between model year 2008 and 2020, fuel economy and footprint increased within each of the five vehicle types, and horsepower increased in four. Weight decreased within each of the vehicle types. These trends within vehicle types are largely attributable to design and technology changes over that time span. In addition to technology changes, the market shifted towards car and truck SUVs, which are often larger, heavier, more powerful, and less fuel efficient than sedan/wagons they replaced. These market changes increased the overall horsepower and footprint of the average new vehicle, compared to technology-driven changes alone. The trend towards larger, heavier, and more powerful vehicles has also offset some of the fleetwide fuel economy and CO_2 emission benefits that otherwise would have been achieved through improving technology. Market trends led to an increase in the weight of a new average vehicle, even as weight fell within each vehicle type.

Most manufacturers have improved CO_2 emissions and fuel economy over the last 5 years

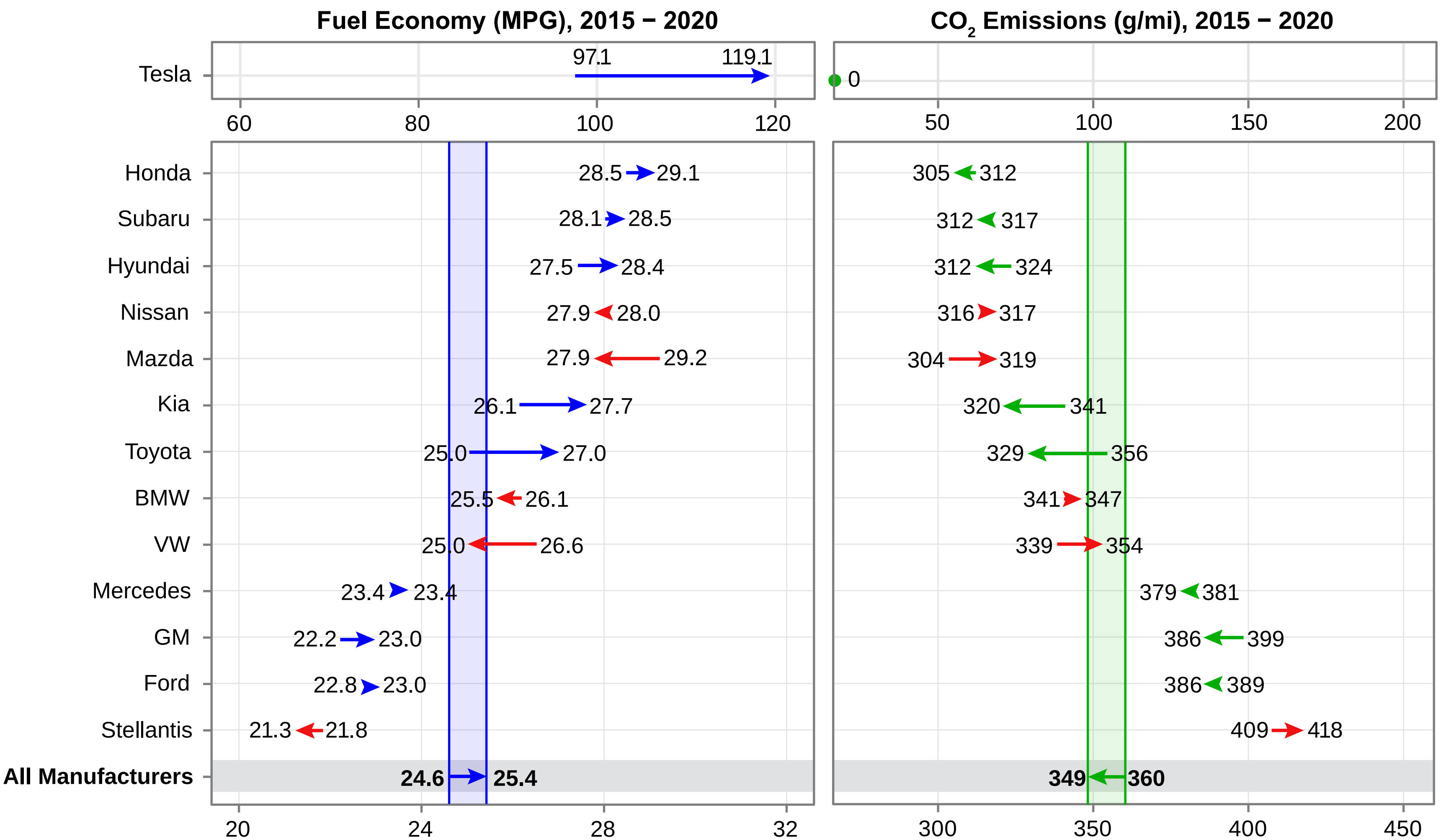
Manufacturer trends over the last five years are shown in Figure ES-4. This span covers the approximate length of a vehicle redesign cycle, and it is likely that most vehicles have undergone design changes in this period, resulting in a more accurate depiction of recent manufacturer trends than focusing on a single year. Changes over this time period can be attributed to changes in both vehicle design and the significant change to the mix of vehicle types produced, as shown in ES-2.

Over the last five years, eight of the fourteen largest manufacturers selling vehicles in the U.S. decreased new vehicle estimated real-world CO_2 emission rates. Tesla was unchanged because their all-electric fleet produces no tailpipe CO_2 emissions. Between model years 2015 and 2020, Toyota achieved the largest reduction in CO_2 emissions, at 27 g/mi. Toyota decreased emissions in all vehicle types, and their mix of vehicle types produced in model years 2015 and 2020 was similar. Kia achieved the second largest reduction in overall CO_2 tailpipe emissions, even as their production share of more efficient sedan/wagons fell from 75% to 53%, and less efficient truck SUVs increased from 3% to 36% of all production. GM had the third largest reduction in overall CO_2 tailpipe emissions, while their production share of sedan/wagons fell from 31% to 13% and truck SUVs increased from 28% to 39% of all production.

Five manufacturers increased new vehicle CO_2 emission rates between model years 2015 and 2020. Volkswagen and Mazda tied for the largest increase at 15 g/mi. Volkswagen achieved reductions in CO_2 emissions in both sedan/wagon and truck SUVs vehicle types; however, that was more than offset by a reduction in their production share of sedan/wagons, from 79% to 40%, and a corresponding increase in truck SUVs from 19% to 58%. Mazda had similar trends, as a drop in sedan/wagon production share from 57% to 24%, a corresponding increase in car and truck SUV production share, and an increase in sedan/wagon CO_2 emissions offset reductions in CO_2 emissions from both car SUVs and truck SUVs.

For model year 2020 alone, Tesla's all-electric fleet had by far the lowest tailpipe CO_2 emissions and highest fuel economy of all large manufacturers. Tesla was followed by Honda, Subaru, and Hyundai. Stellantis had the highest new vehicle average CO_2 emissions and lowest fuel economy of the large manufacturers in model year 2020, followed by Ford and GM.

Figure ES-4. Changes in Estimated Real-World Fuel Economy[1] and CO_2 Emissions for Large Manufacturers



[1]Electric vehicles, including Tesla's all-electric fleet, are measured in terms of miles per gallon of gasoline equivalent, or mpge.

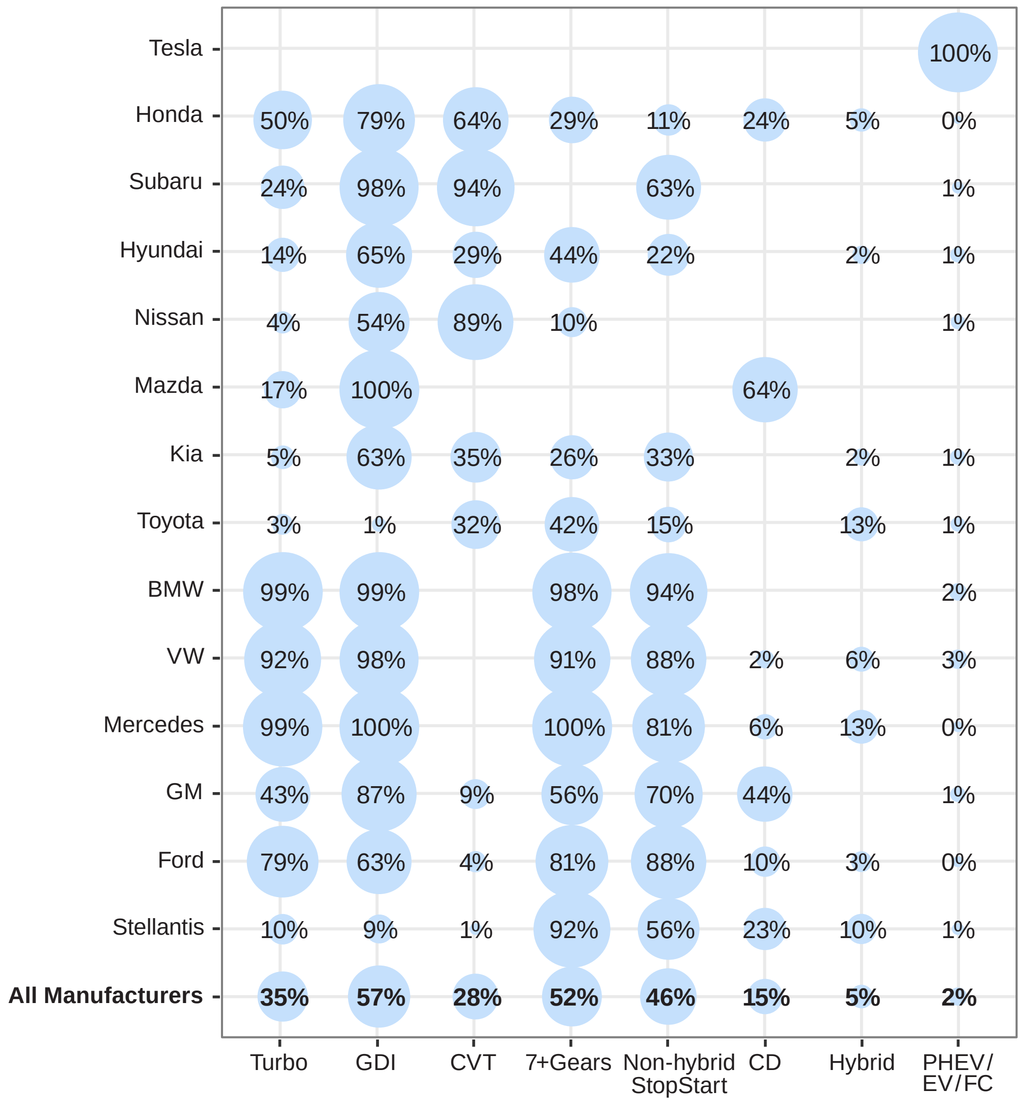
Manufacturers continue to adopt a wide array of advanced technologies

Innovation in the automobile industry has led to a wide array of technology available to manufacturers to achieve CO_2 emissions, fuel economy, and performance goals. Figure ES-5 illustrates manufacturer-specific technology adoption for model year 2020, with larger circles representing higher adoption rates. The technologies in Figure ES-5 are all being adopted by manufacturers to in part reduce CO_2 emissions and increase fuel economy. Each of the fourteen largest manufacturers have adopted several of these technologies into their vehicles, with many manufacturers achieving very high penetrations of several technologies. It is also clear that manufacturers' strategies to develop and adopt new technologies are unique and vary significantly. Each manufacturer is choosing technologies that best meet the design requirements of their vehicles, and in many cases, that technology is changing quickly.

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. The hybrid category includes "full" hybrid systems that can temporarily power the vehicle without engaging the engine and smaller "mild" hybrid systems that cannot propel the vehicle on their own. 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).

Electric vehicles (EVs), plug-in hybrid vehicles (PHEVs), and fuel cell vehicles (FCVs) are a small but growing percentage of new vehicles. Projected data for model year 2021 supports this, as EVs, PHEVs, and FCVs are projected to grow to 4% of all new vehicles. Hybrids (not including PHEVs) are also projected to grow significantly in model year 2021, to 9% of all vehicles produced. Hybrid production is expected to grow in most vehicle types, including truck SUVs and pickups. Approximately one third of these hybrids are projected to be mild hybrids.

Figure ES-5. Technology Share for Large Manufacturers, Model Year 2020



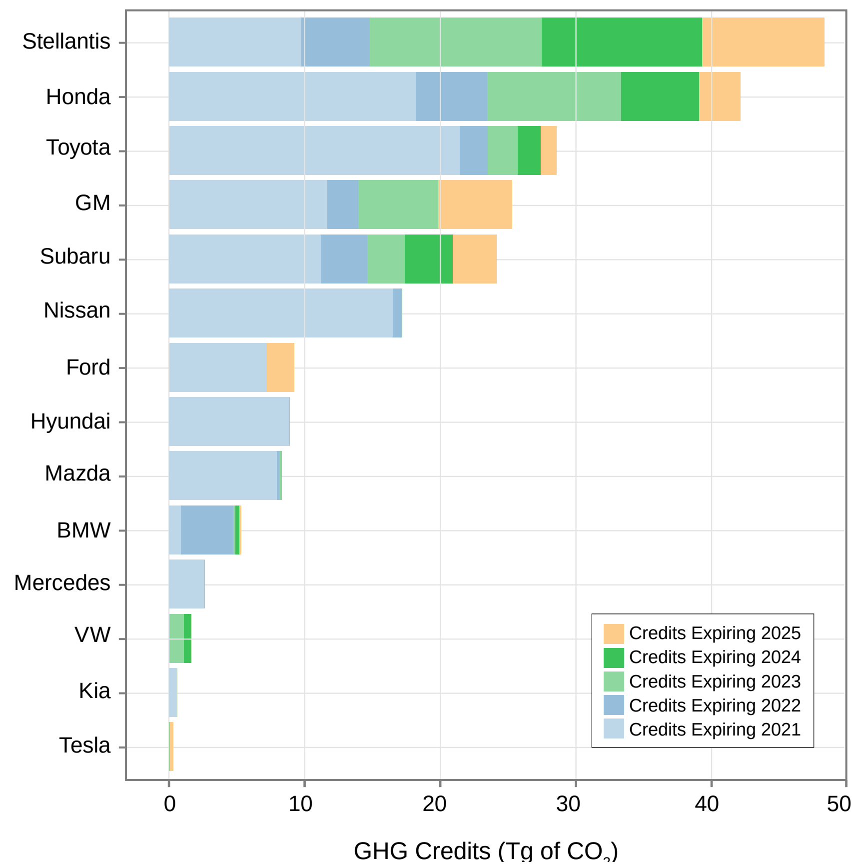
All fourteen large manufacturers achieved compliance with the GHG standards through model year 2020

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.

Within a model year, manufacturers with average fleet emissions lower than the standards generate credits, and manufacturers with average fleet emissions higher than the standards generate deficits. Any manufacturer with a deficit at the end of the model year has up to three years to offset the deficit with credits earned in future model years, or purchased from another manufacturer.

The fourteen largest manufacturers ended model year 2020 with positive credit balances and are thus in compliance for model year 2020 and all previous years of the GHG program, as credits may not be carried forward unless deficits from all prior model years have been resolved.

Figure ES-6. GHG Credit Balance for Large Manufacturers, after Model Year 2020



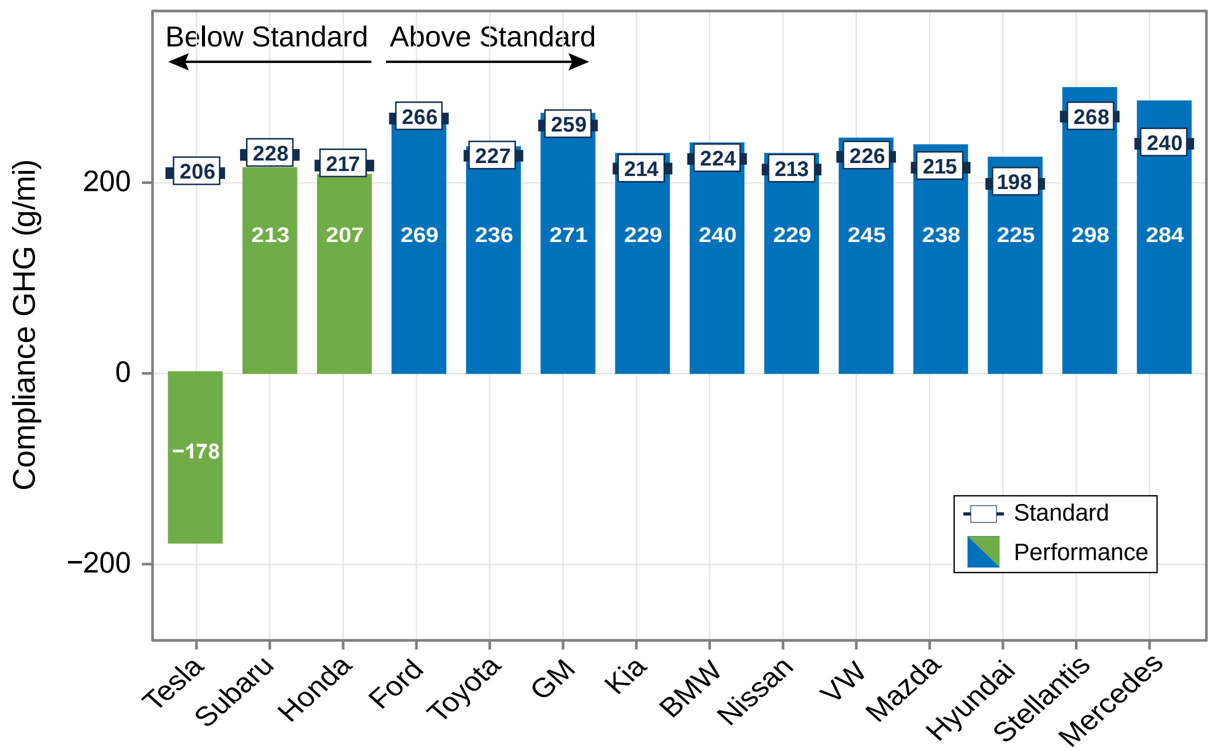
Total credits in Figure ES-6 are shown in **teragrams** (one million Megagrams), and account for manufacturer performance compared to their standards, expected vehicle lifetime miles driven, and the number of vehicles produced by each manufacturer, for all years of the GHG program. The credits accumulated by each manufacturer will be carried forward for use in future model years or until they expire. Credit expiration dates are based on the model year in which they were earned.

Most large manufacturers used banked or purchased credits to maintain compliance in model year 2020

Manufacturers used different combinations of technology improvements, banked credits, and purchased credits to achieve compliance in 2020. Tesla, Honda, and Subaru achieved compliance based on the emission performance of their vehicles, without requiring additional banked credits. All other large manufacturers used banked or purchased credits, along with technology improvements, to achieve compliance in model year 2020.

Figure ES-7 illustrates the performance of individual large manufacturers in model year 2020 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 2020. However, it does not account for the fact that all large manufacturers had credits available from previous years, or they were able to purchase credits to ensure their credit balance remained positive after model year 2020.

Figure ES-7. CO_2 Performance and Standards by Manufacturer, Model Year 2020



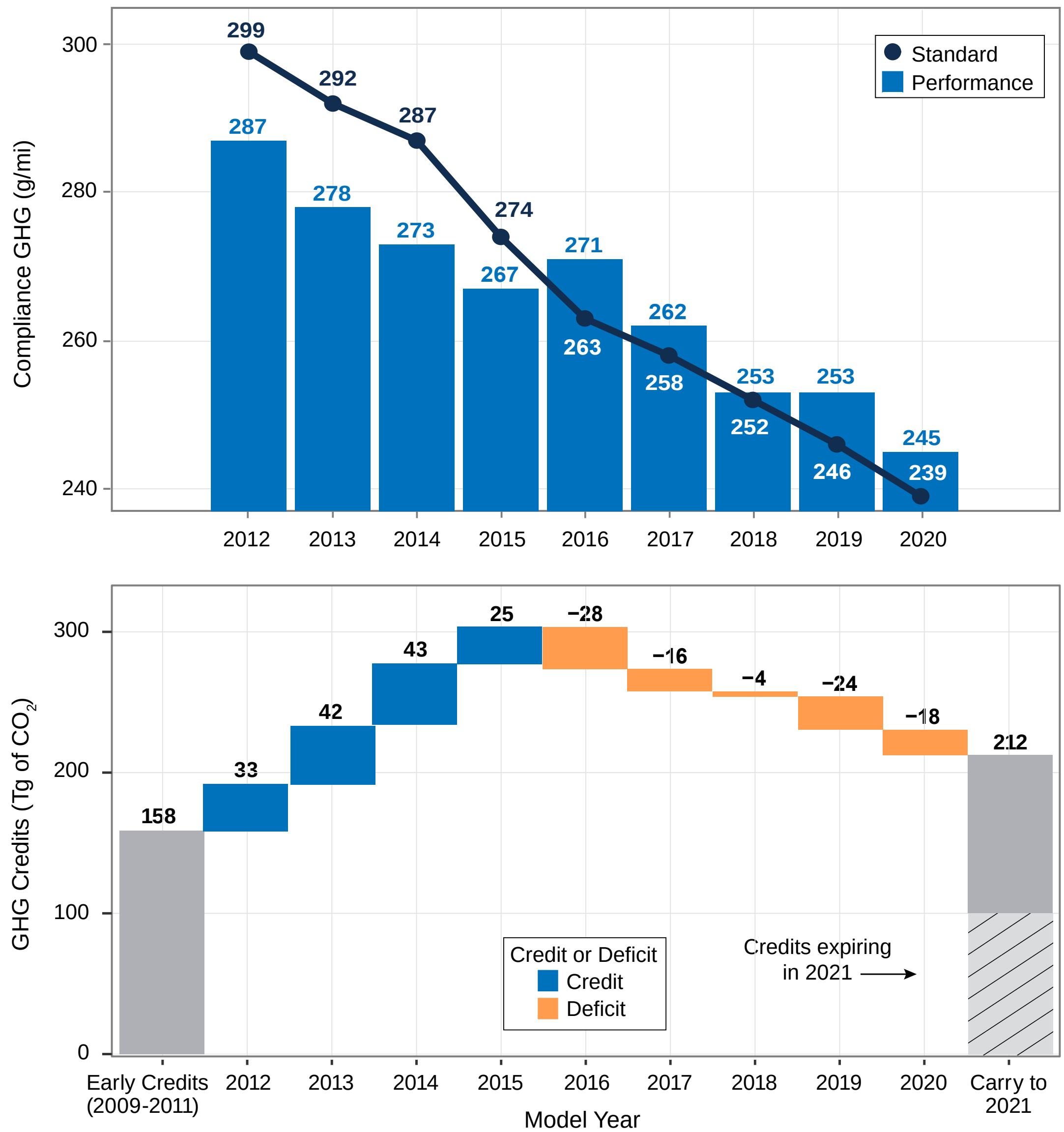
The manufacturer performance values shown in Figure ES-7 are based on the average new vehicle tailpipe emissions for each manufacturer and also include various optional credits available to manufacturers in model year 2020. One notable provision in the regulations is an incentive multiplier that increases the credits each electric vehicle creates. The impact of this incentive is particularly evident for Tesla, since Tesla produces only electric vehicles, and led to the negative performance value for Tesla shown in Figure ES-7.

The overall industry used credits for the fifth year in a row to maintain compliance, and there remains a large bank of credits for future years

Under the GHG Program, manufacturers were able to accrue "early credits," before the GHG standards took effect in model year 2012, for early deployment of efficient vehicles and technology. For the next four years, manufacturers continued to generate credits, as the industry GHG performance was below the industry-wide average standard. In the last five years, the industry GHG performance has been above the industry-wide average standard, resulting in net withdrawals from the bank of credits to maintain compliance. In model year 2020, the industry decreased overall GHG performance to 245 g/mi, while the standard fell from 246 g/mi to 239 g/mi. The gap between the standard and GHG performance fell from 7 g/mi in model year 2019 to 6 g/mi in model year 2020. To maintain compliance the industry drew down their industry-wide total credit bank by about 18 Tg, which was less than 10% of the total available credit balance. The overall industry emerged from model year 2020 with a bank of 212 teragrams (Tg) of GHG credits available for future use, as seen in Figure ES-8.

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 2016 or beyond have a five-year life, while all prior credits (half 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, with nine manufacturers selling credits, nine manufacturers purchasing credits, and approximately 80 credit trades since 2012.

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 interactive data tools, visit the report webpage at www.epa.gov/automotive-trends.