Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2017

Trends

Executive Summary

United States Environmental Protection Agency

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Executive Summary

Introduction

*This report is the authoritative reference for carbon dioxide (CO_2) emissions, fuel economy, and powertrain technology trends for **new** personal vehicles in the United States. The data supporting this report were obtained by the U.S. Environmental Protection Agency (EPA), directly from automobile manufacturers, in support of EPA's greenhouse gas (GHG) emissions and the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) Corporate Average Fuel Economy (CAFE) programs. These data have been collected and maintained by EPA since 1975 and comprise the most comprehensive database of its kind. This report (the "Trends" report) has been published annually since 1975 and covers all passenger cars, sport utility vehicles, minivans, and all but the largest pickup trucks and vans.*

*Data for model years (MY) 1975 through 2016 are **final**. These data are submitted to the EPA and NHTSA at the conclusion of the model year and include actual production data and the results of emission and fuel economy testing performed by the manufacturers and EPA. Data for MY 2017 are **preliminary** and based on projected production data provided to EPA by automakers for vehicle certification and labeling prior to MY 2017 sales. MY 2017 values will be finalized in next year's report. All data in this report are based on production volumes delivered for sale in the U.S. by model year, and may vary from publicized data based on calendar year sales.*

*All of the tailpipe CO_2 emissions and fuel economy values in this Executive Summary are **adjusted** values, which are very similar to new vehicle Fuel Economy and Environment Labels and are EPA's best estimate of nationwide "real world" CO_2 emissions and fuel consumption. EPA periodically updates the methodology used for these calculations based on the best available data. In this report, an updated methodology was applied to MY 2011 and later vehicles. Therefore, the values in this report are not comparable to values in previous reports. For a detailed discussion of fuel economy values and calculation methodology, see Section 10 of the full report.*

*This report does **not** provide formal compliance values for EPA CO_2 emissions standards and NHTSA CAFE standards. Information about automaker compliance with EPA's GHG emissions standards is available in EPA's Manufacturer Performance Report at www.epa.gov/regulations-emissions-vehicles-and-engines/ghg-emission-standards-light-duty-vehicles-manufacturer. Information about automaker compliance with NHTSA's CAFE standards is available at NHTSA's CAFE Public Information Center at https://one.nhtsa.gov/cafe_pic/CAFE_PIC_Home.htm.*

It is important to note that the Department of Justice, on behalf of EPA, alleged violations of the Clean Air Act by Fiat Chrysler Automobiles based on the sale of certain 2014 through 2016 model year vehicles equipped with devices that defeat the vehicles' emission control systems. In addition, the Department of Justice and EPA have reached a settlement with Volkswagen over the use of defeat devices for certain 2009 through 2016 model year vehicles. In this report, EPA uses the CO_2 emissions and fuel economy data from the initial certification of these vehicles. Should the investigation and corrective actions yield different CO_2 and fuel economy data, any relevant changes will be used in future reports. For more information on actions to resolve these alleged violations, see www.epa.gov/fca and www.epa.gov/vw.

The full version of this report and appendices are available at www.epa.gov/fuel-economy-trends.

Highlight

Average new vehicle CO_2 emissions fell by 2 grams per mile to a record low, and fuel economy increased 0.1 miles per gallon to a record high

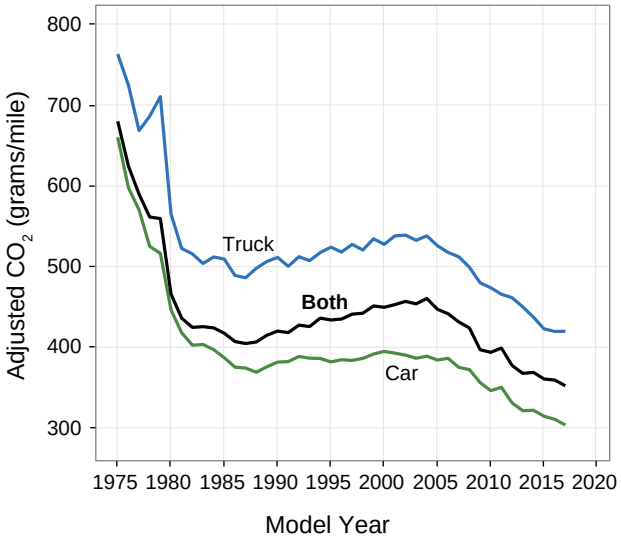
The final MY 2016 adjusted, real world CO_2 emissions rate for all new personal vehicles is 359 g/mi, which is a 2 g/mi decrease from MY 2015 and the lowest level ever. The MY 2016 adjusted fuel economy is 24.7 mpg, which is 0.1 mpg higher than MY 2015, and is a record high.

Both cars and trucks reached record adjusted fuel economy in MY 2016. The average MY 2016 adjusted fuel economy for cars increased to 28.5 mpg, a 0.3 mpg increase over MY 2015. MY 2016 trucks also increased 0.1 mpg to 21.2 mpg.

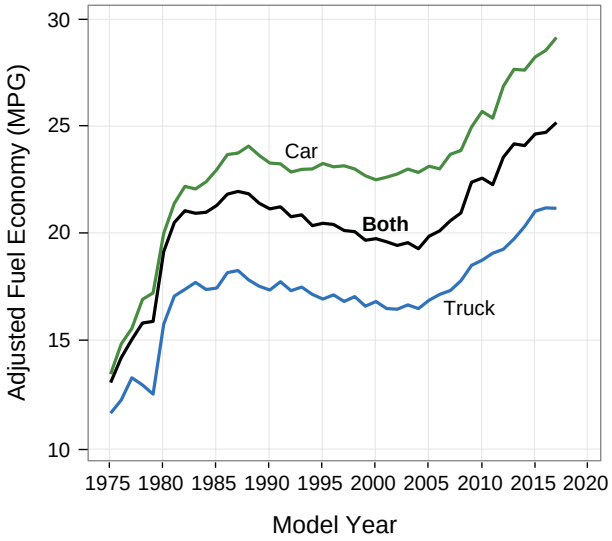
The greatest value of the historical Trends database is the documentation of long-term trends. Since MY 2004, CO_2 emissions and fuel economy have improved in ten out of twelve years, and decreased only twice. CO_2 emissions have decreased by 102 g/mi, or 22%, and fuel economy has increased by 5.4 mpg, or 28%, with an average annual improvement of about 0.5 mpg per year.

Preliminary MY 2017 adjusted CO_2 emissions are projected to be 352 g/mi and fuel economy is projected to be 25.2 mpg, which would be a further improvement over MY 2016. These values are based on production estimates provided by automakers throughout 2016. MY 2017 values will be finalized in next year's report.

Adjusted CO_2 Emissions for MY 1975–2017 [1]



Adjusted Fuel Economy for MY 1975–2017 [1]



[1] *Adjusted CO_2 and fuel economy values reflect real world performance and are not comparable to automaker standards compliance levels. Adjusted CO_2 values are, on average, about 25% higher than the unadjusted, laboratory CO_2 values that form the starting point for GHG standards compliance, and adjusted fuel economy values are about 20% lower, on average, than unadjusted fuel economy values that form the starting point for CAFE standards compliance.*

2 Highlight

Fuel economy continues to increase while weight and power have leveled off

Vehicle weight and power are two important design parameters that help determine a vehicle's CO_2 emissions and fuel economy.

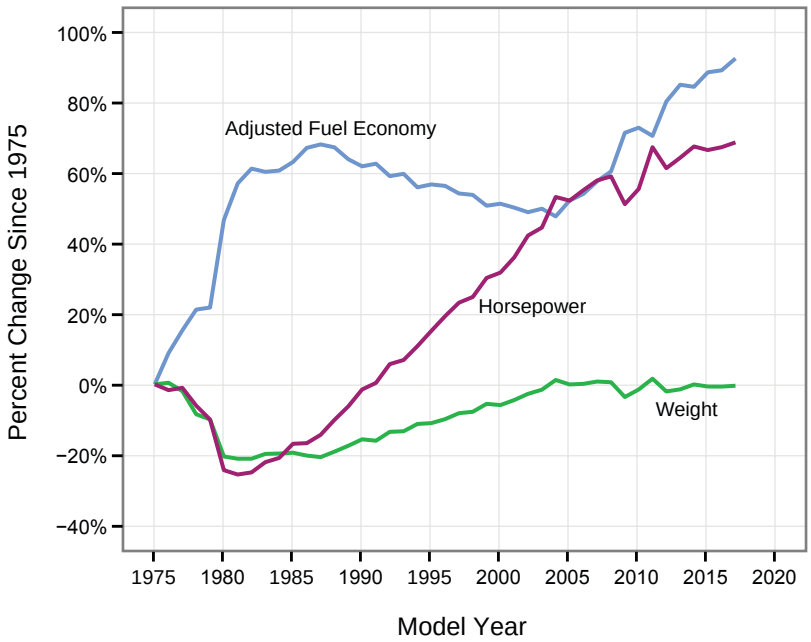
For nearly two decades through MY 2004, on a fleetwide basis, automotive technology innovation was generally utilized to support vehicle attributes other than CO_2 emissions and fuel economy, such as weight, performance, utility, and other attributes. Beginning in MY 2005, technology has generally been used to increase both fuel economy (which has reduced CO_2 emissions) and power, while keeping vehicle weight relatively constant.

The average weight for new vehicles produced in MY 2016 was 4,035 pounds, which was unchanged from MY 2015 although the weight of an average new car fell by 23 pounds, and the weight of an average new truck fell by 24 pounds. The 2.1% increase in truck share offset the weight reductions in cars and trucks, so that overall new vehicle weight was relatively unchanged.

Average new vehicle horsepower (hp) was also basically unchanged in MY 2016, as the average vehicle was 1 hp higher than MY 2015. With an average 230 hp, new vehicles remain at a record high average horsepower. Car horsepower was down by 1 hp and truck horsepower increased by 1 hp. The average 0-to-60 mph acceleration time was the same in MY 2016 as MY 2015.

Preliminary MY 2017 values suggest that average weight will be up 9 pounds and horsepower up 2 hp. EPA will not have final MY 2017 data until next year's report.

Change in Adjusted Fuel Economy, Weight, and Horsepower for MY 1975–2017



3 Highlight

Sport utility vehicles reached record high market share, while also achieving record low CO_2 emissions and record high fuel economy

In this report, vehicles are disaggregated into five vehicle types: car, car SUV, truck SUV, pickup truck, and minivan/van. Car SUVs are generally smaller 2WD SUVs that are considered cars for purposes of compliance with the GHG emissions and fuel economy standards.

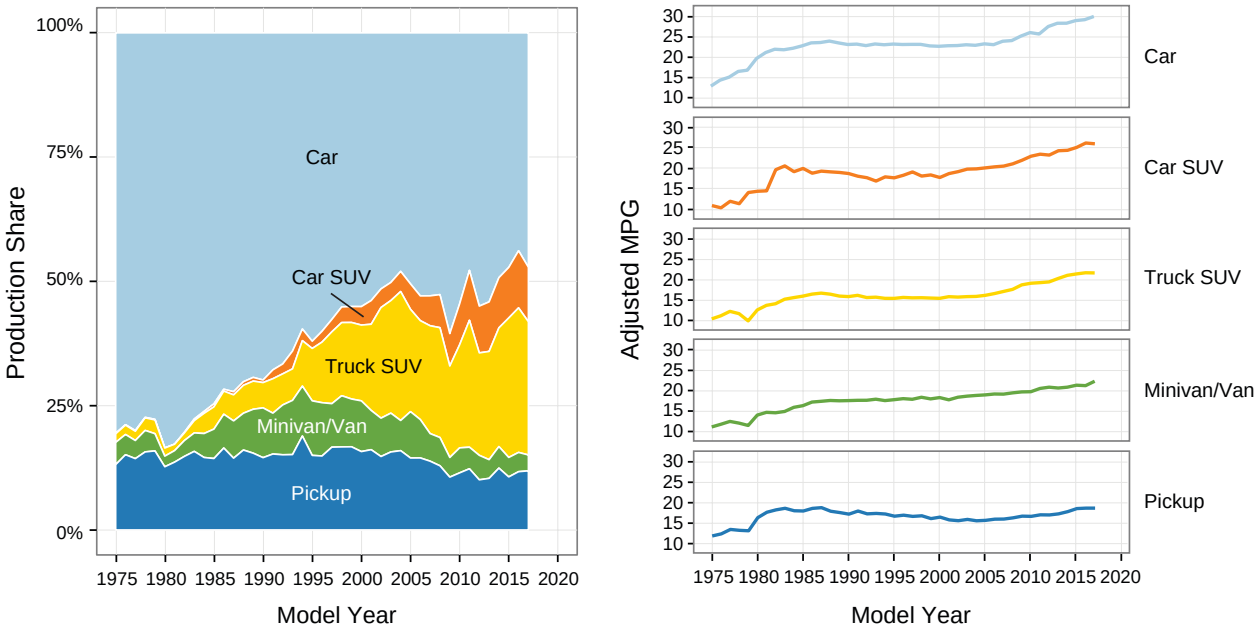
Car SUVs had the largest production share increase of any vehicle type in MY 2016, up 1.3 percentage points to a record 12% of all production. Truck SUVs reached a record market share of 29%, resulting in a record 41% market share for combined SUVs in MY 2016. Car SUVs had the largest increase in fuel economy, at 1.1 mpg. Both car SUVs and truck SUVs achieved record high fuel economy and record low CO_2 emissions, with car SUVs reaching 26.2 mpg and truck SUVs reaching 22.2 mpg.

Pickup trucks increased fuel economy by 0.1 mpg. Pickup trucks are now at their highest recorded fuel economy, tied with the fuel economy achieved in MY 1986 (when trucks were much smaller and on average weighed one third less than new trucks today).

All five vehicle types have steadily increased fuel economy in recent years and are at or near their record high fuel economy levels. However, the market shift towards SUVs has offset some of the fleetwide benefits that otherwise would have been achieved due to the increased fuel economy within each vehicle type. Light trucks, which include pickups, truck SUVs, and minivans/vans, increased market share 2 percentage points in MY 2016, to 45% of production. This remains below the record light truck share of 48% reached in MY 2004.

Preliminary MY 2017 data suggests that overall truck share will drop in MY 2017; however, this projection is particularly uncertain given market conditions and low gasoline prices.

Production Share and Adjusted Fuel Economy by Vehicle Type for MY 1975–2017



4 Highlight

Average new vehicle footprint remains stable

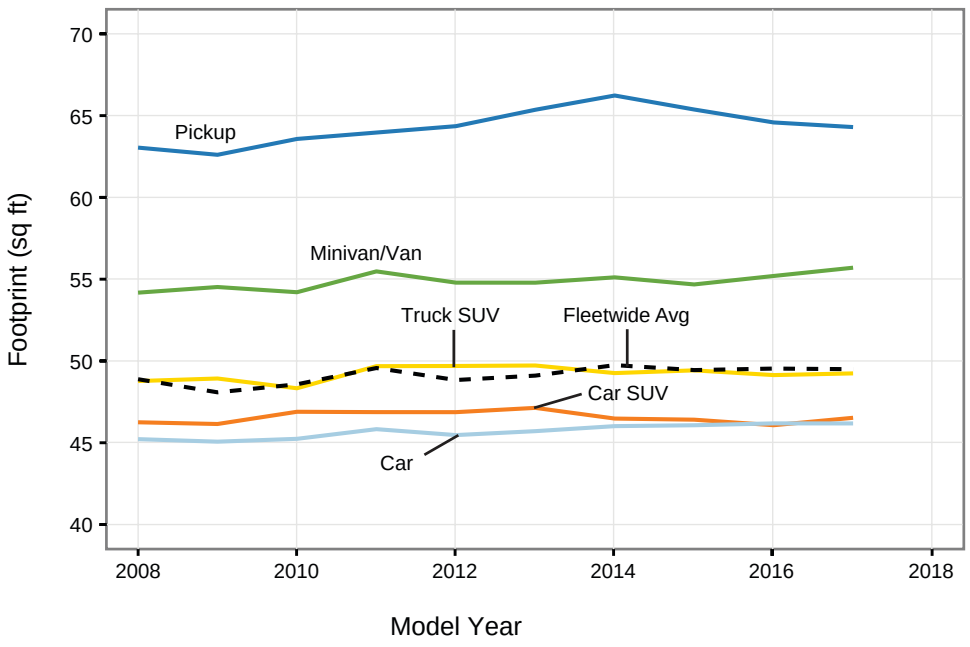
Footprint is an important measure of vehicle size that is defined as the area enclosed by the tires of the vehicle (i.e., wheelbase multiplied by average track width). Both the GHG emissions and fuel economy standards rely on footprint to determine vehicle GHG and fuel economy targets. EPA began collecting industry-wide footprint data in MY 2008.

The average footprint within each of the five vehicle types has been relatively stable between MY 2008 and MY 2016. The average footprint for pickup trucks increased 1.5 ft^2 (2.4%); cars increased 1 ft^2 (2.1%); minivans/vans increased 1.0 ft^2 (1.9%); truck SUVs increased 0.4 ft^2 (0.7%); and car SUVs were down 0.2 ft^2 (-0.4%).

The overall new vehicle average footprint has also been stable between MY 2008 and MY 2016. The overall average is influenced by the trends within each vehicle type, as well as the mix of new vehicles produced. Since MY 2008, market share has shifted towards car SUVs and truck SUVs, and away from cars, pickups, and minivans/vans. The result of this shift, and the accompanying footprint changes within each vehicle type, is that between MY 2008 and MY 2016 the overall industry footprint increased by 0.6 ft^2 (1.2%), to 49.5 ft^2.

Preliminary MY 2017 values are essentially unchanged from MY 2016. The overall new vehicle average footprint is projected to stay the same, at 49.5 ft^2.

Footprint by Vehicle Type for MY 2008–2017



5 Highlight

Seven of the 13 largest manufacturers decreased CO_2 emissions and improved fuel economy in MY 2016

Seven of the thirteen manufacturers shown below decreased CO_2 emissions and five increased fuel economy from MY 2015 to MY 2016.

In MY 2016, Mazda had the lowest fleetwide average adjusted CO_2 emissions and highest adjusted fuel economy performance, followed closely by Hyundai, Honda, Subaru, and Nissan. Fiat-Chrysler[2] had the highest CO_2 emissions and lowest fuel economy. Hyundai had the largest reduction in adjusted CO_2 emissions from MY 2015 to MY 2016, at 15 g/mile.

Four manufacturers increased average adjusted CO_2 emissions between MY 2015 and MY 2016. This is partially explained by increases in truck share for all four, however other companies such as Mazda and Kia had large increases in truck share while improving overall fuel economy.

Preliminary values suggest that nearly all manufacturers will improve in MY 2017, though these projections are uncertain, and EPA will not have final MY 2017 data until next year's report.

MY 2015–2017 Manufacturer Adjusted Fuel Economy and Adjusted CO_2 Emissions[1]

	MY 2015 Final		MY 2016 Final				*MY 2017 Preliminary*	
Manufacturer	**Adj. Fuel Economy (MPG)**	**CO_2 (g/mi)**	**Adj. Fuel Economy (MPG)**	**Change from MY 2015 (MPG)**	**CO_2 (g/mi)**	**Change from MY 2015 (g/mi)**	***Adj. Fuel Economy (MPG)***	***CO_2 (g/mi)***
Mazda	29.2	304	29.6	+0.4	301	-3	*29.3*	*304*
Hyundai	27.5	324	28.8	+1.3	309	-15	*28.9*	*307*
Honda	28.5	312	28.2	-0.3	315	+3	*29.5*	*301*
Subaru	28.1	317	28.1	0	317	0	*28.4*	*312*
Nissan	28.0	316	27.9	-0.1	318	+2	*27.9*	*317*
Kia	26.1	341	26.2	+0.1	338	-3	*27.5*	*323*
BMW	26.1	342	25.5	-0.6	349	+7	*25.6*	*347*
Toyota	25.0	356	25.0	0	355	-1	*26.0*	*341*
Mercedes	23.4	381	23.7	+0.3	376	-5	*24.2*	*366*
Ford	22.8	389	22.8	0	389	0	*22.8*	*390*
GM	22.2	399	22.4	+0.2	397	-2	*23.0*	*386*
Volkswagen[2]	*26.6*	*339*	*26.6*	*0.0*	*334*	*-5*	*26.3*	*337*
Fiat-Chrysler[2]	*21.8*	*409*	*21.5*	-0.3	*413*	*+4*	*21.5*	*413*
All	**24.6**	**361**	**24.7**	**+0.1**	**359**	**-2**	***25.2***	***352***

[1] Adjusted CO_2 and fuel economy values reflect real world performance and are not comparable to automaker standards compliance levels. Adjusted CO_2 values are higher and adjusted fuel economy values are lower than compliance values.
[2] Volkswagen and FCA (Fiat-Chrysler) are listed separately in this table due to an ongoing investigation and/or corrective actions. These data are based on initial certification data, and are included in industry-wide or "All" values. Should the investigation and corrective actions yield different CO_2 and fuel economy data, any relevant changes will be used in future reports.

6 Highlight

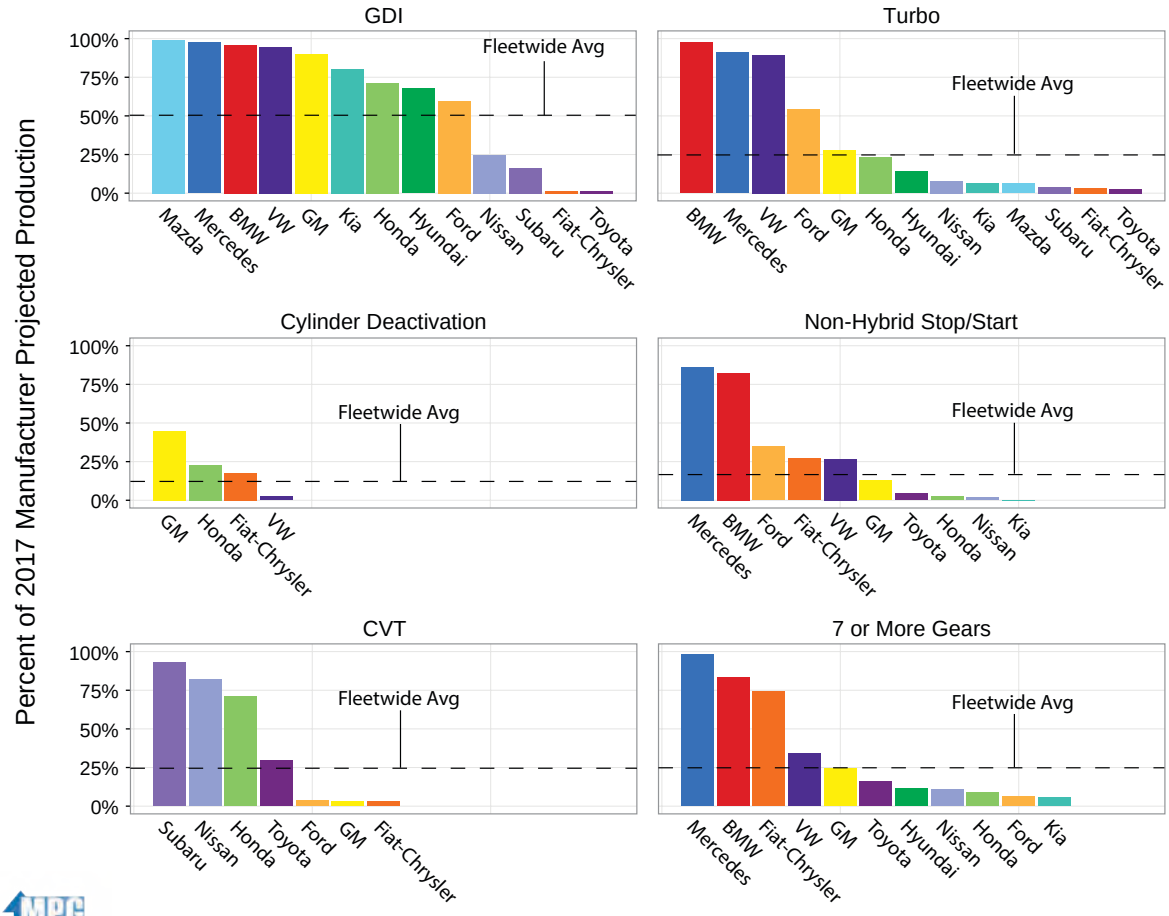
Manufactures continue to adopt a wide array of advanced technologies

Technological innovation is a major driving force in the industry. Though the industry overall has adopted several technologies quickly in recent years, individual manufacturers are clearly utilizing different technologies to achieve CO_2 emissions, fuel economy, and performance goals. The figure below illustrates projected manufacturer-specific technology adoption for MY 2017.

Gasoline direct injection (GDI) has achieved widespread use by many manufacturers and is projected to be used on over half of all vehicles in MY 2017. This is particularly impressive since GDI was used in fewer than 3% of vehicles as recently as MY 2008. All Mazda engines are projected to use GDI in MY 2017, with several other manufacturers at nearly 100% adoption. Turbochargers, which are often used in conjunction with GDI, have also increased market share to 25% in MY 2017, led by BMW, Mercedes, VW, and Ford.

Transmission technology has also changed rapidly with about 24% of MY 2017 vehicles projected to use transmissions that have seven or more speeds, with an additional 24% relying on continuously variable transmissions (CVT). Subaru, Nissan, and Honda are leading in adoption of CVTs, while Mercedes, BMW, and Fiat-Chrysler lead in the adoption of transmissions with seven or more speeds. Mercedes and BMW are the leading manufacturers for non-hybrid stop/start, and GM and Honda are utilizing cylinder deactivation the most.

Manufacturer Adoption of Emerging Technologies for MY 2017



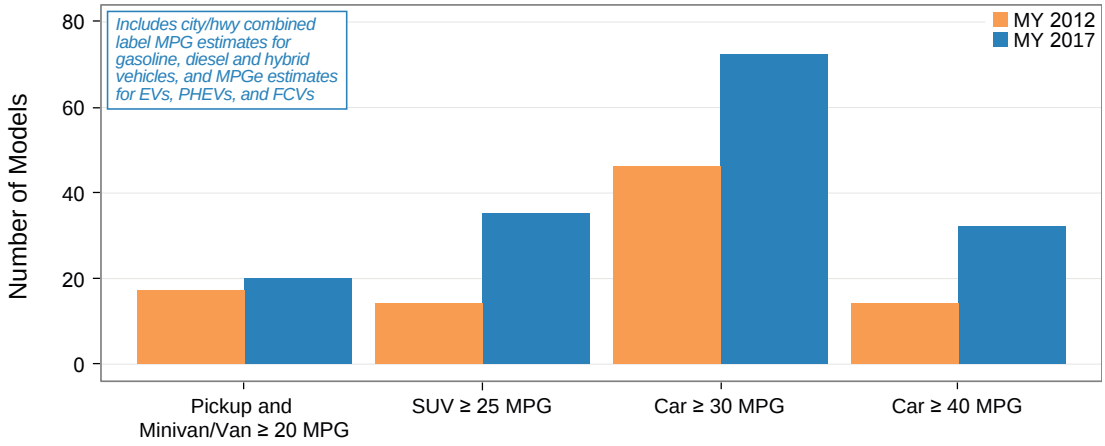
Highlight

Consumers have an increasing number of high fuel economy/ low CO_2 vehicle choices

In MY 2017, consumers have more choices when shopping for vehicles with higher fuel economy and lower tailpipe CO_2 emissions compared to MY 2012. These choices reflect both a more diverse range of technology packages on conventional gasoline and diesel vehicles as well as an increasing number of electric and plug-in hybrid electric vehicle offerings.

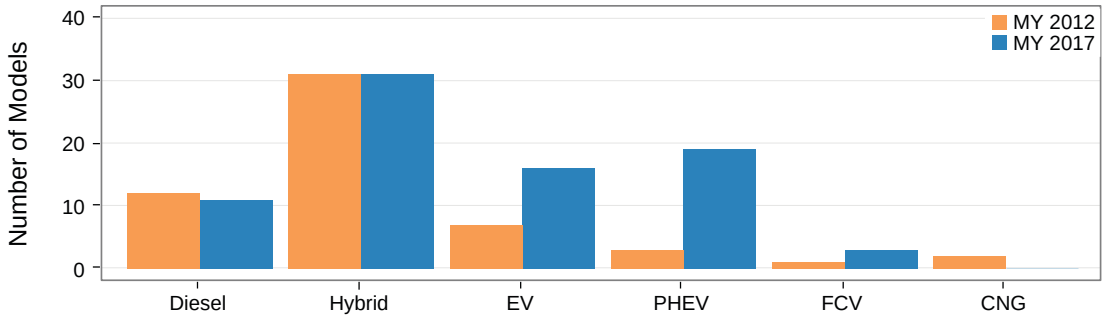
There are 20 MY 2017 pickup and minivan/van models for which at least one variant of the model has a combined city/highway label fuel economy rating of 20 mpg or more, a small increase over MY 2012. There are more than twice as many SUV models that achieve at least 25 mpg in MY 2017 than there were in MY 2012. The number of car models, where at least one variant has a combined city/highway label fuel economy of at least 30 mpg, has grown from 46 models in MY 2012 to more than 70 models in MY 2017, and the number of car models with 40 mpg or higher has more than doubled (comprised of hybrid, electric (EV), plug-in hybrid electric (PHEV), and fuel cell vehicles (FCV)).

Vehicle Models Meeting Fuel Economy Thresholds in MY 2012 and 2017



In MY 2017 there were 35 EV and PHEV models available, more than triple the number available in MY 2012. There are also more fuel cell vehicle models, and the same number of hybrid models. The number of diesel vehicle models available fell slightly, and no CNG vehicle models were available in MY 2017.

Advanced Technology and Alternative Fuel Vehicle Models in MY 2012 and 2017



Highlight

About a quarter of MY 2017 vehicles already meet or exceed MY 2020 targets, or roughly half of what might be necessary for compliance

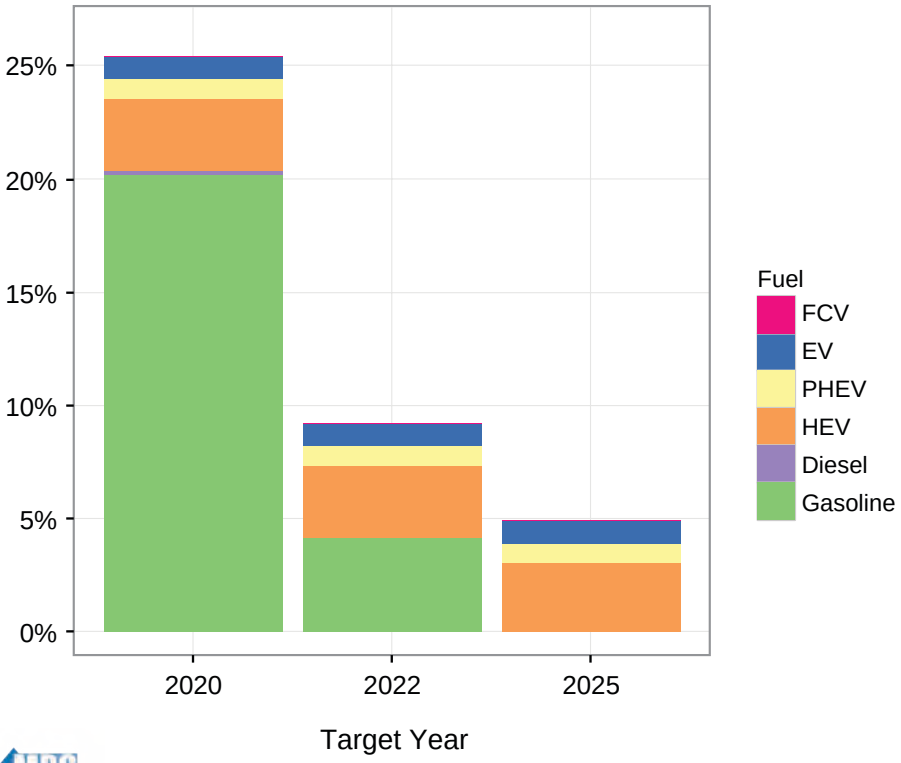
EPA evaluated MY 2017 vehicle emissions against future footprint-based CO_2 regulatory targets to determine which current vehicles could meet or exceed their future targets. These comparisons assume future improvements in air conditioner refrigerants and efficiency, since these improvements are considered to be among the least expensive methods to reduce greenhouse gas emissions. The analysis also assumes that manufacturers will receive, on average, 5 grams/mile of off-cycle credits in all years.

It is important to note that there are no CO_2 emissions standards for individual vehicles. Overall manufacturer compliance is determined based on the manufacturer specific production-weighted average footprint and CO_2 emissions. It is fully expected that there will be a distribution of how manufacturers' vehicles compare to their fuel economy targets; some will be above their targets and some will be below. Manufacturers will likely be able to achieve compliance with roughly 50% of their vehicles meeting or exceeding the standards.

The figure below shows that 26% of projected MY 2017 vehicle production already meets or exceeds the MY 2020 CO_2 emissions targets, with the addition of expected air conditioning improvements and off-cycle credits. This represents approximately 4.5 million vehicles per year being sold today. The number of vehicles meeting or exceeding the MY 2020 standards has steadily increased with each model year. Including air conditioning and off-cycle credits, fewer than 5% of MY 2012 vehicles met or exceeded the MY 2020 standards, the majority of which were hybrids. By MY 2017, improvements in non-hybrid gasoline vehicles led to 26% of MY 2017 vehicles meeting or exceeding the MY 2020 standards.

Looking ahead, about 5% of projected MY 2017 production could meet the MY 2025 CO_2 emissions targets. Vehicles meeting the MY 2025 CO_2 targets are comprised solely of hybrids (HEV), plug-in hybrids (PHEV), electric vehicles (EV) and hydrogen fuel cell vehicles (FCV).

MY 2017 Vehicle Production That Meets or Exceeds Future CO_2 Emissions Targets



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.