Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2013

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 detailed data supporting this report were obtained by the U.S. Environmental Protection Agency (EPA), directly from automobile manufacturers, to support implementation of EPA's greenhouse gas (GHG) emissions and the U.S. Department of Transportation National Highway Traffic Safety Administration's (NHTSA) Corporate Average Fuel Economy (CAFE) programs. These data have been collected and rigorously maintained by EPA since 1975, and comprise the most comprehensive and authoritative database of its kind.*

Since 1975, this report (often referred to as the "Trends" report) has been published annually and covers new personal vehicles, including all passenger cars, sport utility vehicles, minivans, and all but the largest pickup trucks and vans. This report supersedes, and should not be compared to, all previous Trends reports because major methodological changes are propagated backwards through the historical database in order to maintain the integrity of long-term trends.

*All of the tailpipe CO_2 emissions and fuel economy values in this Executive Summary are **adjusted 5-cycle** values which reflect urban commuting, rural highway, high speed/high acceleration, high temperature/air conditioning, and cold temperature operation. These adjusted values are very similar to new car Fuel Economy and Environment Labels and when aggregated on a fleetwide basis, yield EPA's best estimate of nationwide "real world" CO_2 emissions and fuel consumption, but are not comparable to the values submitted by automakers for standards compliance. Adjusted CO_2 emissions values are significantly higher than, and adjusted fuel economy values are significantly lower than, the **unadjusted, laboratory 2-cycle** values that form the basis for automaker compliance with EPA CO_2 emissions standards (which began in model year 2012) and NHTSA CAFE standards (which have been in place since model year 1978).*

In early 2014, EPA intends to publish a separate, annual GHG Report at epa.gov/otaq/regs/ld-hwy/greenhouse/ld-ghg.htm that will summarize individual manufacturer performance toward meeting the MY 2012 GHG emissions standards. NHTSA at nhtsa.dot.gov/fuel-economy also publishes a separate document summarizing automaker compliance with fuel economy standards entitled, "Summary of Fuel Economy Performance." NHTSA will prepare an updated report after EPA provides NHTSA with complete and final data through MY 2012. At the time of publication, EPA is in the process of submitting final manufacturer-specific CAFE values to NHTSA and the manufacturers.

The Trends report has been extensively rewritten this year and includes new sections and many new tables and figures. While this summary includes the most important highlights of the report, the reader is encouraged to consult the full report for more depth. The full report, as well as the appendices, is available at epa.gov/otaq/fetrends.htm.

The following Highlights summarize the most important conclusions of this report.

Highlight

Average vehicle CO_2 emissions rate and fuel economy achieved record levels in MY 2012, and have improved in 7 of the last 8 years

The final model year (MY) 2012 adjusted, real world CO_2 emissions rate is 376 g/mi, which is a 22 g/mi decrease relative to MY 2011. MY 2012 adjusted fuel economy is 23.6 mpg, which is 1.2 mpg higher than MY 2011. Both values represent all-time records since the database began in MY 1975, and the authors believe that these represent historical records as well. The 1.2 mpg fuel economy improvement from MY 2011 to MY 2012 is the second largest annual improvement in the last 30 years.

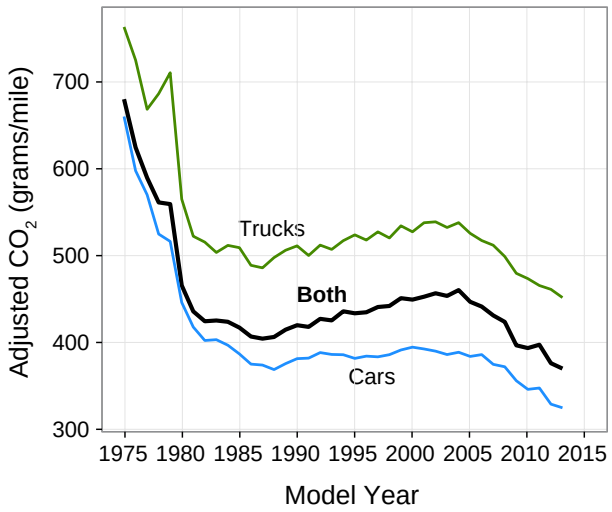
CO_2 emissions and fuel economy have now improved in seven of the last eight years. This recent positive trend reversed the long negative trend from MY 1987 through MY 2004.

Preliminary MY 2013 adjusted values are 370 g/mi CO_2 emissions and 24.0 mpg fuel economy, which, if achieved, will again represent all-time records. Final values for MY 2013 will be published in next year's report.

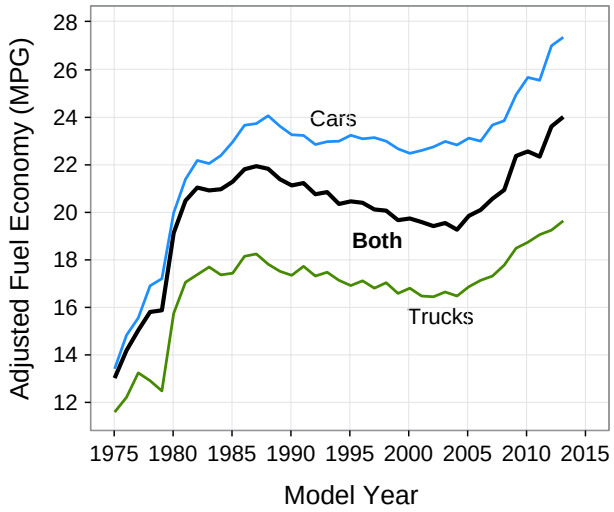
While the direction and magnitude of changes from year-to-year often receive the most public attention, the greatest value of the historical Trends database is the documentation of long-term trends. This is because: 1) year-to-year volatility can reflect short-term trends (e.g., the economic recession and Cash for Clunkers rebates in 2009 and the impact of the tsunami on Japan-based manufacturers in 2011) that may not be meaningful from a long-term perspective, and 2) the magnitude of year-to-year changes in annual CO_2 emissions and fuel economy tend to be small relative to longer, multi-year trends.

Based on the final Trends data through MY 2012, CO_2 emissions have decreased by 85 g/mi, or 18%, since MY 2004, and fuel economy has increased by 4.3 mpg, or 22%.

Adjusted CO_2 Emissions for MY 1975-2013[1]



Adjusted Fuel Economy for MY 1975-2013[1]



[1] *Adjusted CO_2 and fuel economy values reflect real world estimates 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.*

2 Highlight

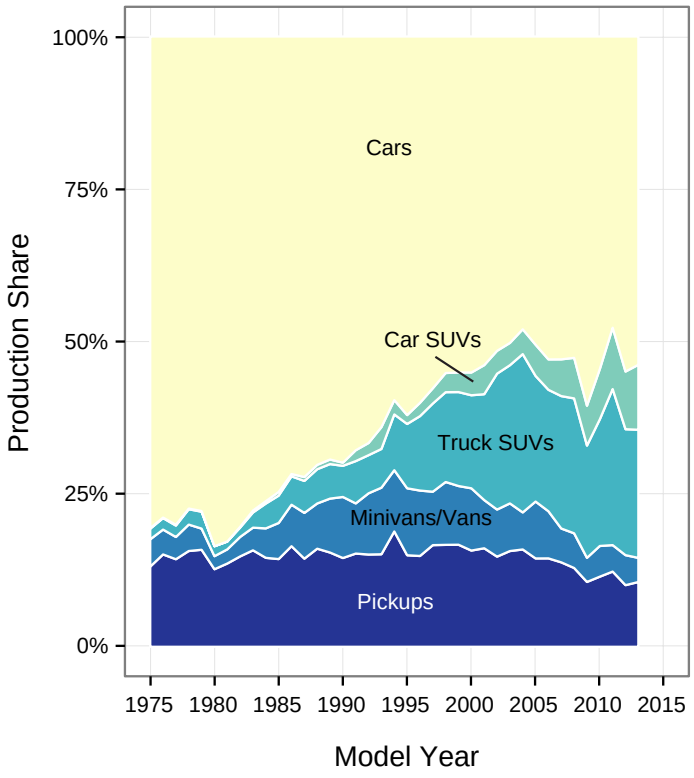
Light truck market share decreased in MY 2012, but continues to be variable

Light trucks, which include pickups, minivans/vans, and truck SUVs (SUVs that must meet light truck GHG emissions and fuel economy standards), accounted for 36% of all light-duty vehicle production in MY 2012, the second lowest level since 1993. This represents a 6% decrease relative to MY 2011, and essentially offsets the 5% increase from MY 2010 to MY 2011. The MY 2013 light truck market share is projected to remain at 36%, based on pre-model year projections by automakers.

Light truck market share has been variable in recent years, e.g., truck share has changed by 4% or more in each year for MY 2009-2012, with two years of increases and two years of decreases. Three factors that have likely contributed to the volatility in truck share include: 1) MY 2009 was a particularly unusual year due to the serious economic recession that led to much turmoil in the automotive market and almost certainly led to an artificially low truck production share in that year; 2) the Car Allowance Rebate System (CARS), commonly referred to as Cash for Clunkers, managed by NHTSA, which provided incentives of up to $4500 for the trade-in of a vehicle with lower fuel economy and purchase of a new vehicle with higher fuel economy, resulted in 677,081 new vehicle purchases in 2009, and 3) the earthquake, tsunami, and nuclear tragedies in Japan in March 2011, which decreased the supply of cars from Japan, and likely contributed to the truck share increase in MY 2011 (as well as to the projected truck share decrease in MY 2012).

Cars include conventional cars and car SUVs (SUVs that must meet car GHG emissions and fuel economy standards).

Production Share by Vehicle Type for MY 1975-2013



3 Highlight

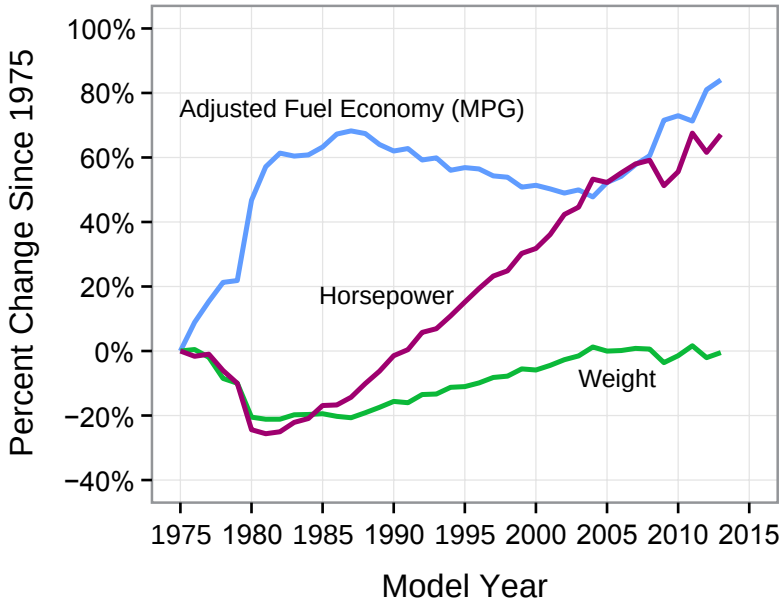
Vehicle weight trend is flat and increasing vehicle power trend is slowing

Vehicle weight and performance are two of the most important design parameters that help determine a vehicle's CO_2 emissions and fuel economy. In general, all other factors being equal, higher vehicle weight and faster acceleration performance (e.g., lower 0-to-60 miles-per-hour acceleration time), both increase a vehicle's CO_2 emissions and decrease fuel economy.

MY 2012 vehicle weight averaged 3,977 pounds, a decrease of 150 pounds compared to MY 2011. Average MY 2012 vehicle power was 222 horsepower, a decrease of 8 horsepower from MY 2011. Estimated 0-to-60 acceleration time in MY 2012 was unchanged at 9.4 seconds. Average vehicle footprint declined by 0.7 square feet in MY 2012. The decrease in light truck market share was a major factor in the lower weight, horsepower, and footprint.

Preliminary MY 2013 values suggest that average vehicle weight and power will both increase, though these projections are uncertain, and EPA will not have final data until next year's report. The preliminary MY 2013 average weight is relatively unchanged over the last decade. The preliminary MY 2013 horsepower value would tie the record first set in MY 2011.

Change in Adjusted Fuel Economy, Weight, and Horsepower for MY 1975-2013



From MY 1987 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, and utility. Beginning in MY 2005, technology has been used to increase both fuel economy (which has reduced CO_2 emissions) and power, while keeping vehicle weight relatively constant.

Tables 2.1 (cars plus light trucks), 3.3.1 (cars), and 3.3.2 (light trucks) provide data on key vehicle attributes.

Highlight 4

Many new technologies are rapidly gaining market share

New technologies are continually being introduced into the marketplace, replacing older and less effective technologies. Technological innovation is a major driving force behind the recent improvements in CO_2 emissions and fuel economy, and the majority of the carbon and oil savings from current vehicles is due to new gasoline vehicle technologies. The figure below shows changes in market share over the five-year period from MY 2008 through MY 2013 for several key engine and transmission technologies for which Trends gathers data.

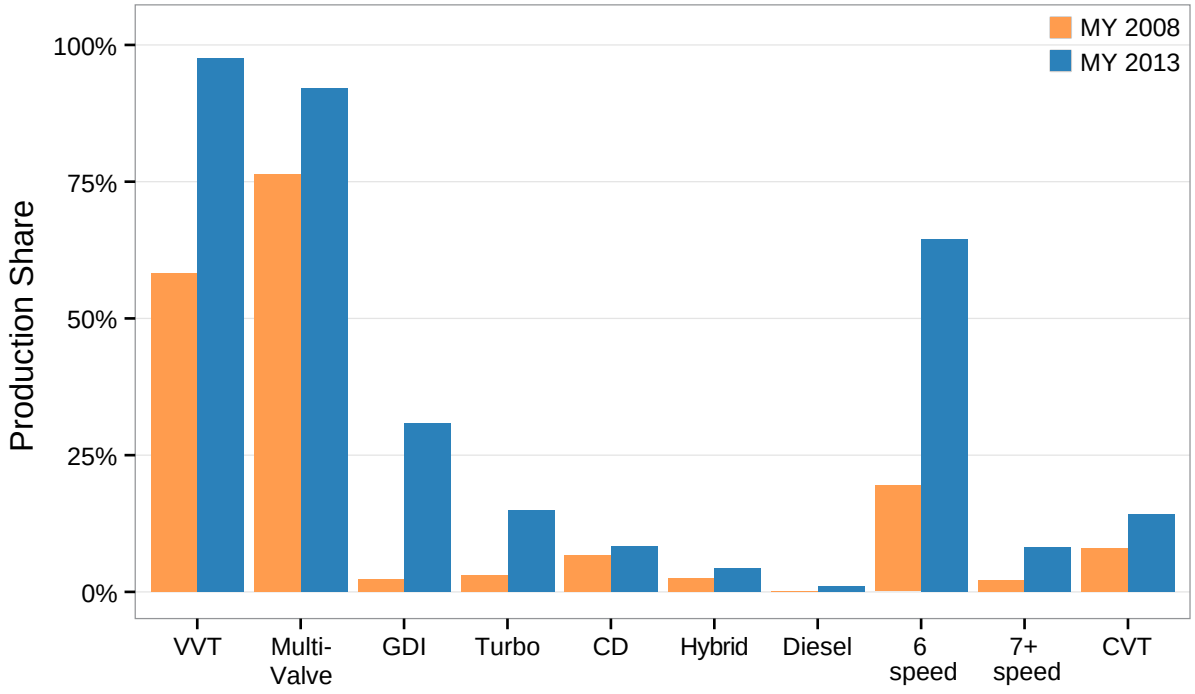
Two engine technologies first introduced over 20 years ago—variable valve timing (VVT) and multi-valve engines—are both projected to be used on over 90% of MY 2013 vehicles.

Gasoline direct injection (GDI) engines have increased market share ten-fold from less than 3% in MY 2008 to over 30% in MY 2013. Turbochargers, which are often used in conjunction with GDI, have increased market share by a factor of five since MY 2008.

Transmissions with 6 or more speeds and continuously variable transmissions (CVTs) cumulatively accounted for about 30% of vehicle production in MY 2008, but are projected to exceed 80% market share in MY 2013.

Compared to the engine and transmission technologies discussed above, there has been far less growth in the production shares of hybrid and diesel powertrains (see Highlight 5 for the increase in the number of hybrid and diesel models), and cylinder deactivation (CD).

Technology Production Share for MY 2008 and MY 2013



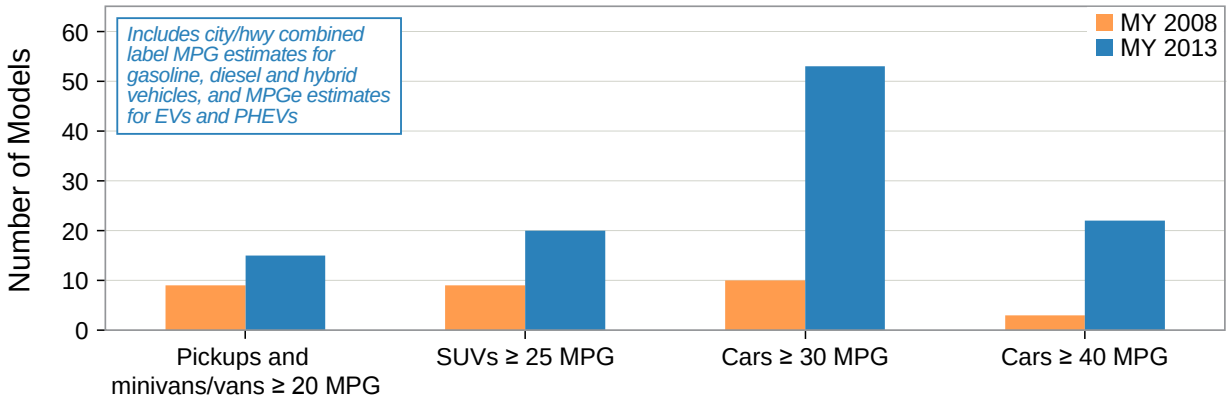
Highlight

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

Consumers have more choices than ever when shopping for vehicles with higher fuel economy and lower tailpipe CO_2 emissions. These choices reflect both a more diverse range of technology packages on conventional gasoline vehicles as well as more advanced technology and alternative fueled vehicles.

There are 15 MY 2013 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, compared with nine models five years ago. There are over twice as many SUV models that achieve 25 mpg or more in MY 2013 than in MY 2008. The number of non-hybrid SUVs that achieved 25 mpg increased from four in MY 2008 to 17 in MY 2013, more than a four-fold increase. The number of car models where at least one variant has a combined city/highway label fuel economy of 30 mpg or more increased by five-fold, and the number of car models at 40 mpg or more have increased from three to over 20 (all hybrid, electric and plug-in hybrid electric vehicles).

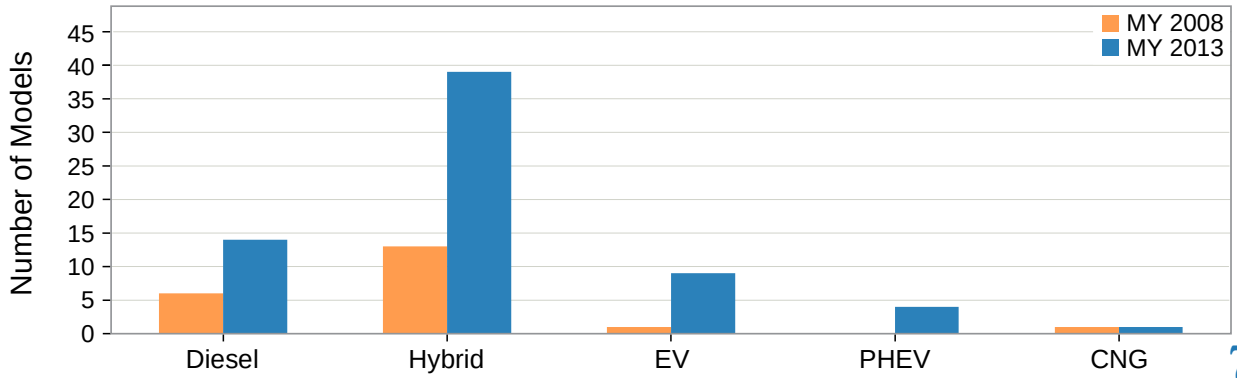
Vehicle Models Meeting Fuel Economy Thresholds in MY 2008 and MY 2013



There are also many more advanced technology vehicle choices. In MY 2013, there are three times as many hybrid offerings as there were in MY 2008. In addition, the number of diesel offerings has doubled, and there are growing numbers of electric vehicles and plug-in hybrid electric vehicles as well.

Section 8 provides more detail about the methodology for this "model count" analysis, and also shows that, within individual models, consumers have a wider range of high fuel economy performance from which to choose.

Advanced Technology and Alternative Fuel Vehicle Models in MY 2008 and MY 2013



Highlight

Nearly every manufacturer increased fuel economy in MY 2012, resulting in lower CO_2 emission rates

Ten of the eleven manufacturers shown below increased fuel economy from MY 2011 to MY 2012, the last two years for which we have definitive data. Preliminary MY 2013 values suggest that most manufacturers will improve in MY 2013 as well, though these projections are uncertain, and EPA will not have final data until next year's report.

In MY 2012, for the 11 manufacturers shown, Mazda had the lowest fleetwide adjusted composite CO_2 emissions and highest adjusted fuel economy performance, followed by Honda. Chrysler-Fiat had the highest CO_2 emissions and lowest fuel economy, followed by Daimler. Daimler had the biggest improvement in adjusted CO_2 emissions performance from MY 2011 to MY 2012, with a 43 g/mi reduction, followed by Honda with a 35 g/mi reduction. Honda had the biggest fuel economy improvement from MY 2011 to MY 2012, of 2.5 mpg, while Mazda had the second largest increase of 2.1 mpg.

Section 4 has greater detail on the fuel economy and CO_2 emissions for these manufacturers (e.g., for individual manufacturer car and light truck fleets), as well as for individual makes (i.e., brands).

MY 2011–2013 Manufacturer Adjusted Fuel Economy and Adjusted CO_2 Emissions[1]

	MY 2011 Final		MY 2012 Final				MY 2013 Preliminary	
Manufacturer[2]	Fuel Economy (MPG)	CO_2 Emissions (g/mi)	Fuel Economy (MPG)	Change from MY 2011 (MPG)	CO_2 Emissions (g/mi)	Change from MY 2011 (g/mi)	Fuel Economy (MPG)	CO_2 Emissions (g/mi)
Mazda	25.0	356	27.1	+2.1	328	-28	27.5	324
Honda	24.1	369	26.6	+2.5	334	-35	27.0	329
Toyota	24.1	369	25.6	+1.5	347	-22	25.2	352
VW	26.0	349	25.8	-0.2	351	+2	26.2	346
Subaru	23.9	372	25.2	+1.3	352	-20	26.2	339
Nissan	23.3	381	24.1	+0.8	369	-12	25.3	351
BMW	22.7	393	23.7	+1.0	377	-16	24.4	364
Ford	21.1	422	22.8	+1.7	390	-32	22.6	394
GM	20.7	429	21.7	+1.0	410	-19	22.0	404
Daimler	19.1	469	21.1	+2.0	426	-43	22.2	402
Chrysler-Fiat	19.4	458	20.1	+0.7	442	-16	21.6	411
All	**22.4**	**398**	**23.6**	**+1.2**	**376**	**-22**	**24.0**	**370**

[1] *Adjusted CO_2 and fuel economy values reflect real world estimates 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.*

[2] *Two manufacturers, Hyundai and Kia, are not included in rows in the table above due to a continuing investigation. On November 2, 2012, EPA announced that Hyundai and Kia would lower their fuel economy estimates for many vehicle models as the result of an EPA investigation of test data. Based on these corrected data, Hyundai's values are 27.2 mpg and 327 g/mi CO_2 for MY 2011, 28.3 mpg and 314 g/mi CO_2 for MY 2012, and 28.3 mpg and 315 g/mi CO_2 for MY 2013 (preliminary). Kia's values are 25.8 mpg and 345 g/mi CO_2 for MY 2011, 26.5 mpg and 336 g/mi CO_2 for MY 2012, and 27.3 mpg and 326 g/mi CO_2 for MY 2013 (preliminary). These corrected data for Hyundai and Kia are included in industry-wide or "All," values.*

Highlight

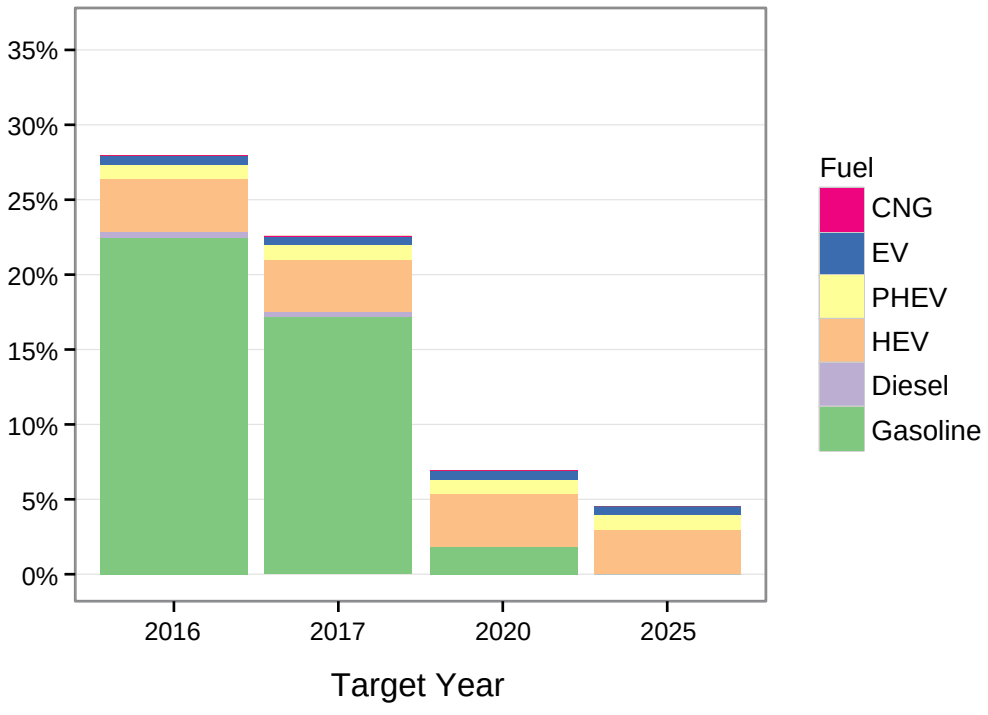
Manufacturers are selling many vehicles today that can meet future CO_2 emissions targets

EPA evaluated MY 2013 vehicles against future footprint-based CO_2 emissions regulatory targets to determine which vehicles could meet or exceed their future targets in MY 2016-2025. These comparisons were based on current powertrain designs, assuming improvements only in air conditioner refrigerants and efficiency. EPA assumed air conditioning improvements since these are considered to be among the most straightforward and least expensive technologies available to reduce CO_2 and other greenhouse gas emissions. It is important to note there are no CO_2 emissions standards for individual vehicles. Rather, there are manufacturer-specific compliance levels for both passenger car and light truck fleets. The compliance levels for each manufacturer are derived from the footprint-based CO_2 emissions target curves, and the production volume-weighted distribution of vehicles produced for sale in the U.S. by each manufacturer.

The figure below shows that 28% of projected MY 2013 vehicle production already meets the MY 2016 CO_2 emissions targets, or can meet these targets with the addition of expected air conditioning improvements. The bulk of this production share is accounted for by non-hybrid gasoline vehicles, although other technologies, including diesels, hybrids, plug-in electric hybrids, electric vehicles, and compressed natural gas vehicles, are also represented.

Looking ahead, about 5% of projected MY 2013 production could meet the MY 2025 CO_2 emissions targets. Vehicles meeting the MY 2025 CO_2 targets are comprised solely of hybrids, plug-in hybrids, and electric vehicles. Since the MY 2025 standards are over a decade away, there's considerable time for continued improvements in gasoline vehicle technology.

MY 2013 Vehicle Production Share That Meets 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.