Questions and Answers

Greenhouse Gas Emissions from a Typical Passenger Vehicle

The U.S. Environmental Protection Agency (EPA) developed this fact sheet to answer common questions about greenhouse gas emissions from passenger vehicles. This fact sheet provides emission rates and calculations consistent with EPA's regulatory work.

How much tailpipe carbon dioxide (CO_2) is created from burning one gallon of fuel?

The amount of CO_2 created from burning one gallon of fuel depends on the amount of carbon in the fuel. Typically, more than 99% of the carbon in a fuel is emitted as CO_2 when the fuel is burned. Very small amounts are emitted as hydrocarbons and carbon monoxide, which are converted to CO_2 relatively quickly in the atmosphere. Carbon content varies by fuel, and some variation within each type of fuel is normal. The EPA and other agencies use the following average carbon content values to estimate CO_2 emissions:

CO_2 Emissions from a gallon of gasoline:	8,887	grams CO^2/ gallon[1]
CO_2 Emissions from a gallon of diesel:	10,180	grams CO^2/ gallon[2]

Diesel creates about 15% more CO_2 per gallon. However, many vehicles that use diesel fuel achieve higher fuel economy than similar vehicles that use gasoline, which generally offsets the higher carbon content of diesel fuel.

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1 This gasoline factor is from a recent regulation establishing GHG standards for model year 2012-2016 vehicles (75 FR 25324, May 7, 2010).

2 This diesel factor is from the calculations that vehicle manufacturers use to measure fuel economy (40 C.F.R 600.113).

EPA United States Environmental Protection Agency

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How much tailpipe carbon dioxide (CO_2) is emitted from driving one mile?

The average passenger vehicle emits about 411 grams of CO_2 per mile. This number can vary based on two factors: the fuel economy of the vehicle and the amount of carbon in the vehicle's fuel. Most vehicles on the road in the U.S. today are gasoline vehicles, and they average about 21.6 miles per gallon.[3] Every gallon of gasoline creates about 8,887 grams of CO_2 when burned. Therefore, the average vehicle when driving one mile has tailpipe CO_2 emissions of about:

$$CO_2 \textit{ emissions per mile} = \frac{CO_2 \textit{ per gallon}}{\textit{MPG}} = \frac{8{,}887}{21.6} = \mathbf{411\ \textit{grams}}$$

This value will decrease slightly each year as standards become more stringent.

What are the average annual carbon dioxide (CO_2) emissions of a typical passenger vehicle?

A typical passenger vehicle emits about 4.7 metric tons of carbon dioxide per year. This number can vary based on a vehicle's fuel, fuel economy, and the number of miles driven per year. The average gasoline vehicle on the road today has a fuel economy of about 21.6 miles per gallon and drives around 11,400 miles per year[4]. Every gallon of gasoline burned creates about 8,887 grams of CO_2, and there are one million grams per metric ton. Therefore, the average vehicle over a year of driving has tailpipe CO_2 emissions of about[5]:

$$\textit{Annual } CO_2 \textit{ emissions} = \frac{CO_2 \textit{ per gallon}}{\textit{MPG}} \times \textit{miles} = \frac{8{,}887}{21.6} \times 11{,}400 = \mathbf{4.7\ \textit{metric tons}}$$

EPA uses this to compare CO_2 emissions from other sources to emissions from passenger vehicles. For example, an energy efficiency program that reduces greenhouse gas emissions by 4,700 metric tons of CO_2 per year has the same impact as removing 1,000 vehicles from the road.

Are there other sources of greenhouse gas (GHG) emissions from a vehicle?

In addition to carbon dioxide (CO_2), automobiles produce methane (CH_4) and nitrous oxide (N_2O) from the tailpipe and hydrofluorocarbon (HFC) emissions from leaking air conditioners.

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3 Federal Highway Administration Highway Statistics 2012. This is representative of the light duty passenger vehicle fleet as a whole, including both new and existing vehicles. EPA expects the average passenger vehicle fuel economy to increase over time as a result of new greenhouse gas and fuel economy standards developed in coordination between EPA, DOT and California.

4 Federal Highway Administration Highway Statistics 2012.

5 This calculation provides a simple way to determine the average annual CO^2 emissions from a passenger vehicle. Anyone that needs a more detailed approach should use the EPA's Motor Vehicle Emission Simulator (MOVES) model. This model contains detailed data about the light duty fleet and driving patterns in the United States. Although simplified, the calculated annual CO^2 emissions above are consistent with analyses performed by the EPA using MOVES.

The emissions of these gases are small in comparison to CO_2; however, the impact of these emissions can be important because they have a higher global warming potential (GWP) than CO_2.

The global warming potential of a gas relates the impact of that gas relative to an equivalent amount of CO_2. Using global warming potentials, the impact of various GHGs can be directly compared using a common metric. This metric is expressed in units of carbon dioxide equivalent, written as CO_2e. Multiplying the amount of a GHG times the global warming potential of that GHG results in the amount of GHG in terms of CO_2e. For automotive-related gases, these global warming potentials are:

Greenhouse Gas	Abbreviation	GWP[6]
Carbon Dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298
Air Conditioning Refrigerant	HFC-134a	1,430

It is more difficult to estimate vehicle emissions of CH_4, N_2O, and HFCs than CO_2. Emissions of CH_4 and N_2O are dependent on the design of the engine and emission control system, rather than fuel consumption per mile. The amount of HFC leakage from air conditioners is dependent on system design, amount of use, and maintenance. On average, CO_2 emissions are 95-99% of the total greenhouse gas emissions from a passenger vehicle, after accounting for the global warming potential of all GHGs. The remaining 1-5% is CH_4, N_2O, and HFC emissions.

What are the tailpipe emissions from a plug-in hybrid electric vehicle (PHEV) or an electric vehicle (EV)? What about hydrogen fuel cell vehicles?

A vehicle that operates exclusively on electricity (an EV) will not emit any tailpipe emissions. A fuel cell vehicle operating on hydrogen will emit only water vapor.

Calculating tailpipe emissions for PHEVs is more complicated. PHEVs can operate on electricity only, gasoline only, or some combination of electricity and gasoline. A PHEV operating on electricity only (like an EV) does not generate any tailpipe emissions. When a PHEV is operating on gasoline only, it creates tailpipe emissions based on the PHEV's gasoline fuel economy. Tailpipe emissions for a PHEV operating on both electricity and gasoline cannot be calculated without detailed information about how the PHEV operates. The overall tailpipe emissions for a PHEV can vary significantly based on the PHEV's battery capacity, how it is driven, and how often it is charged.

For more information, see the "My Plug-In Hybrid" calculator.

[6] These 100-year time horizon GWP values are from the 2007 Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report.

Are there any greenhouse gas emissions associated with the use of my vehicle other than what comes out of the tailpipe?

Driving most vehicles creates tailpipe greenhouse gas emissions. Producing and distributing the fuel used to power your vehicle also creates greenhouse gasses. Gasoline, for example, requires extracting oil from the ground, transporting it to a refinery, refining the oil into gasoline, and transporting the gasoline to service stations. Each of these steps can produce additional greenhouse gas emissions.

Electric vehicles (EVs) have no tailpipe emissions; however, emissions are created during both the production and distribution of the electricity used to fuel the vehicle. Visit the Beyond Tailpipe Emissions calculator to estimate GHG emissions for an EV in your region of the country.

I thought my gasoline was blended with ethanol. Does that change my tailpipe CO_2 emissions?

Most of the gasoline sold in the U.S.is a mixture of gasoline and up to 10% ethanol (often referred to as E10). The exact formulation of the gasoline in your vehicle will vary depending on season, region in the U.S., and other factors. While your fuel economy when using an ethanol blend in your vehicle will be slightly lower than when using gasoline without ethanol, the CO_2 tailpipe emissions per mile will be similar. This is because ethanol has less carbon per gallon than gasoline.

How does the EPA measure CO_2 emissions from vehicles?

The EPA and automobile manufacturers measure vehicle fuel economy and CO_2 emissions using a set of standardized laboratory tests. These tests were designed by the EPA to mimic typical driving patterns. The EPA and the Department of Transportation use these values to ensure that manufacturers meet federal greenhouse gas and corporate average fuel economy (CAFE) standards.

For every new vehicle, the test results are used to determine real world fuel economy and CO_2 emissions. These adjusted results are used on the Fuel Economy and Environment Labels and on Fueleconomy.gov.

For more information, see Frequent Questions on Fuel Economy Testing and Labeling and How Vehicles Are Tested.

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How can I find and compare CO_2 emission rates for specific vehicle models?

Visit Fueleconomy.gov and click on "Find a Car."

When shopping at a dealership, check out tailpipe CO_2 emission rates on vehicle *Fuel Economy and Environment Labels*. The labels also feature a 1-to 10 Fuel Economy and Greenhouse Gas Rating to enable easy comparison shopping.

Where can I find information on the emissions of the transportation sector as a whole?

You can find documents on greenhouse gas emissions on the EPA's Transportation and Climate website. This website is maintained by the Office of Transportation and Air Quality (OTAQ).

The EPA also publishes industry-wide data in the report, "Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends." This report analyzes trends in fuel economy and CO_2 emissions for new light duty vehicles from 1975 to the present.

Other useful sources include:

- Fueleconomy.gov
- Green Vehicle Guide
- U.S. Greenhouse Gas Inventory Report
- Greenhouse Gas Equivalencies Calculator
- Household Carbon Footprint Calculator

For additional information on calculating emissions of greenhouse gases, please contact OTAQpublicweb@epa.gov, or you can contact the OTAQ library for document information at:

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