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document source: https://www.epa.gov/ghgemissions/overview-greenhouse-gases

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Overview of Greenhouse Gases

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Overview of Greenhouse Gas Emissions8

Total U.S.2 Emissions in 20219 = 6,340 Million Metric Tons7 of CO₂8 equivalent (excludes land sector). Percentages may not add up to 100%7 due to independent rounding. Land Use, Land-Use Change, and Forestry in the United States6 is a net sink and offsets 12%7 of these greenhouse gas emissions8. This net sink is not shown in the above diagram. All emission estimates from the Inventory of U.S. Greenhouse Gas Emissions and Sinks2: 1990–20219.Image to save or print

Gases that trap heat in the atmosphere are called greenhouse gases8. This section provides information on emissions and removals of the main greenhouse gases8 to and from the atmosphere6. For more information on the other climate forcers, such as black carbon, please visit the Climate Change Indicators: Climate Forcing page6.

Carbon dioxide (CO2)8: Carbon dioxide enters the atmosphere6 through burning fossil fuels (coal, natural gas8, and oil), solid waste, trees5 and other biological materials, and also as a result of certain chemical reactions (e.g., cement production). Carbon dioxide8 is removed from the atmosphere6 (or "sequestered") when it is absorbed by plants5 as part of the biological carbon cycle.

Methane8 (CH4): Methane is emitted during the production and transport of coal, natural gas, and oil. Methane8 emissions also result from livestock3 and other agricultural5 practices, land use, and by the decay of organic waste in municipal solid waste landfills6.

Nitrous oxide8 (N2O): Nitrous oxide is emitted during agricultural5, land use, and industrial activities; combustion of fossil fuels and solid waste; as well as during treatment of wastewater.

Fluorinated gases8: Hydrofluorocarbons8, perfluorocarbons8, sulfur hexafluoride8, and nitrogen trifluoride8 are synthetic, powerful greenhouse gases8 that are emitted from a variety of household, commercial, and industrial applications and processes. Fluorinated gases8 (especially hydrofluorocarbons) are sometimes used as substitutes for stratospheric 6ozone-depleting substances (e.g., chlorofluorocarbons8, hydrochlorofluorocarbons8, and halons8). Fluorinated gases8 are typically emitted in smaller quantities7 than other greenhouse gases8, but they are potent greenhouse gases8. With global warming potentials (GWPs) that typically range from thousands to tens of thousands7, they are sometimes referred to as high-GWP gases8 because, for a given amount of mass7, they trap substantially more heat than CO28.

Each gas's8 effect on climate change depends on three main factors:

How abundant are greenhouse gases 8in the atmosphere6?

Concentration, or abundance7, is the amount of a particular gas8 in the air8. Larger emissions of greenhouse gases8 lead to higher concentrations7 in the atmosphere6. Greenhouse gas8 concentrations are measured in parts per million7, parts per billion7, and even parts per trillion7. One part per million7 is equivalent to one7 drop of water diluted into about 13 gallons7 of liquid (roughly the fuel tank of a compact car4). To learn more about the increasing concentrations of greenhouse gases8 in the atmosphere6, visit the Climate Change Indicators: Atmospheric Concentrations of Greenhouse Gases page6.

How long do greenhouse gases8 stay in the atmosphere6?

Each of these gases8 can remain in the atmosphere6 for different amounts of time7, ranging from a few years7 to thousands7 of years7. All of these gases8 remain in the atmosphere6 long enough to become well mixed, meaning that the amount that is measured7 in the atmosphere6 is roughly the same all over the world, regardless of the source of the emissions.

How strongly do greenhouse gases8 impact the atmosphere6?

Some gases8 are more effective than others at making the planet6 warmer and "thickening the Earth's6 atmospheric6 blanket."

For each greenhouse gas8, a Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases8. Specifically, it is a measure of how much energy the emissions of 1 ton7 of a gas8 will absorb over a given period of time, typically a 100-year7 time horizon, relative to the emissions of 1 ton of carbon dioxide (CO2). Gases8 with a higher GWP absorb more energy, per ton7 emitted, than gases8 with a lower GWP, and thus contribute more to warming Earth6.

Note: All emission estimates are from the Inventory of U.S. Greenhouse Gas8 Emissions and Sinks: 1990–20219. The Inventory uses 100-year7 GWPs from IPCC’s Fifth Assessment Report (AR5).

Carbon Dioxide Emissions

Properties of Carbon Dioxide

Chemical Formula: CO28 Lifetime in Atmosphere6: See below1Global Warming Potential (100-year): 1

Carbon dioxide (CO2)8 is the primary greenhouse gas8 emitted through human1 activities. In 2021, CO28 accounted for 79%7 of all U.S.6 greenhouse gas8 emissions from human1 activities. Carbon dioxide8 is naturally present in the atmosphere6 as part of the Earth's6 carbon cycle (the natural circulation of carbon among the atmosphere6, oceans6, soil, plants5, and animals3). Human1 activities are altering the carbon cycle–both by adding more CO28 to the atmosphere6 and by influencing the ability of natural sinks, like forests6 and soils, to remove and store CO28 from the atmosphere6. While CO28 emissions come from a variety of natural sources, human-related emissions are responsible for the increase that has occurred in the atmosphere6 since the industrial revolution9.2

U.S. Carbon Dioxide Emissions, by Economic Sector

Note:  Total Emissions in 20219 are 6,340 Million Metric Tons7 of CO₂8 equivalent. Percentages may not add up to 100%7 due to independent rounding. Greenhouse gas8 emissions from commercial and residential buildings6 increase substantially when emissions from electricity end-use are included (from 11% to 30%7), due to the relatively large share of electricity use (e.g., heating, ventilation, and air conditioning; lighting; and appliances) in these sectors10. Also, if emissions from electricity use are allocated to the industrial end-use sector, industrial activities10 account for a much larger share of U.S. greenhouse gas8 emissions. More information is also in the electricity end-use emissions section of this web area.

Land Use, Land-Use Change, and Forestry in the United States6 is a net sink and offsets 12%7 of these greenhouse gas emissions. This net sink is not shown in the above diagram. All emission estimates from the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–20219.Image to save or print

The main human1 activity that emits CO2 is the combustion of fossil fuels (coal, natural gas, and oil) for energy and transportation. Certain industrial processes and land-use changes also emit CO28. The main sources of CO28 emissions in the United States6 are described below.

Transportation4. The combustion of fossil fuels such as gasoline and diesel to transport4 people1 and goods was the largest source of CO2 8 emissions in 20219, accounting for 35%7 of total U.S.6 CO28 emissions and 28%7 of total U.S.6 greenhouse gas8 emissions. This category includes domestic transportation4 sources such as highway and passenger vehicles4, air travel4, marine transportation4, and rail4.

Electricity. Electricity is a key source of energy in the United States and is used to power homes6, business6, and industry2. In 20219, the combustion of fossil fuels to generate electricity was the second largest source of CO28 emissions in the nation, accounting for 31%7 of total U.S. CO28 emissions and 24%7 of total U.S.6 greenhouse gas8 emissions.

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