U.S. Greenhouse Gas Emissions

Energy from the sun drives the Earth's weather and climate. The Earth absorbs some of the energy it receives from the sun and radiates the rest back toward space. However, certain gases in the atmosphere, called greenhouse gases (GHGs), absorb some of the energy radiated from the Earth and trap it in the atmosphere. These gases essentially act as a blanket, making the Earth's surface warmer than it otherwise would be. This "greenhouse effect" occurs naturally, making life as we know it possible. Since the Industrial Revolution began in the late 1700s, however, people have added GHGs into the atmosphere by burning fossil fuels, cutting down forests, and conducting other activities (e.g., agriculture). The resulting substantial increase in GHG concentrations (see the GHG Concentrations indicator) is causing the atmosphere to trap more heat and leading to changes in the Earth's climate.

A number of factors influence the quantities of GHGs released into the atmosphere by human activities, including economic activity, population, consumption patterns, energy prices, land use, and technology. There are several ways to track these emissions, such as by measuring emissions directly, calculating emissions based on the amount of fuel that people burn, and estimating other activities and their associated emissions. EPA has two key programs that provide data on greenhouse gas emissions in the United States: the Inventory of U.S. Greenhouse Gas Emissions and Sinks and the Greenhouse Gas Reporting Program.

This indicator focuses on U.S. emissions of carbon dioxide, methane, nitrous oxide, and several fluorinated gases—all important greenhouse gases that are influenced by human activities. These particular gases are covered under the United Nations Framework Convention on Climate Change, an international agreement that requires participating countries to develop and periodically submit an inventory of greenhouse gas emissions. Data and analysis for this indicator come from EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020* (U.S. EPA, 2022). This indicator is restricted to emissions associated with human activities. It starts in 1990, which is a common baseline year for global agreements to track and reduce greenhouse gas emissions.

Each greenhouse gas has a different lifetime (how long it stays in the atmosphere) and a different ability to trap heat in our atmosphere. To allow different gases to be compared and added together, emissions are converted into carbon dioxide equivalents. This step uses each gas's 100-year global warming potential, which measures how much a given amount of the gas is estimated to contribute to global warming over a period of 100 years after being emitted. Carbon dioxide is assigned a global warming potential equal to 1. This analysis uses global warming potentials from the Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report. In that report, methane has a global warming potential of 25, which means a ton of methane emissions contributes 25 times as much warming as a ton of carbon dioxide emissions over 100 years, and that ton of methane emissions is therefore equal to 25 tons of carbon dioxide equivalents. See the table of key gases for comparison with global warming potentials from IPCC's Sixth Assessment Report. For additional perspective, this indicator also shows greenhouse gas emissions in relation to economic output and population.

What the Data Show

In 2020, U.S. greenhouse gas emissions totaled 5,981 million metric tons (13.2 trillion pounds) of carbon dioxide equivalents. This total represents a 7 percent decrease since 1990 and a 20 percent decrease since 2005 (see Exhibit 1).

For the United States, during the period from 1990 to 2020 (see Exhibit 1):

- Emissions of carbon dioxide, the primary greenhouse gas emitted by human activities, decreased by 8 percent.
- Methane emissions decreased by 17 percent, as reduced emissions from landfills, coal mines, and natural gas systems more than offset increases in emissions from activities such as livestock production (U.S. EPA, 2022).
- Nitrous oxide emissions, predominantly from agricultural soil management practices, such as the use of nitrogen as a fertilizer, decreased by 5 percent.
- Emissions of fluorinated gases (hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride), released as a result of commercial, industrial, and household uses, increased by 90 percent.

U.S. greenhouse gas emissions decreased from 2019 to 2020 by 9 percent. This sharp decline is largely due to the impacts of the coronavirus (COVID-19) pandemic on travel and economic activity. However, the decline also reflects the combined impacts of long-term trends in many factors, including population, economic growth, energy markets, technological changes including energy efficiency, and the carbon intensity of energy fuel choices.

Among the various sectors of the U.S. economy, electricity generation (power plants) accounts for the largest share of historical emissions—31 percent of total greenhouse gas emissions since 1990. Transportation has historically been the second-largest sector, accounting for 26 percent of emissions since 1990 (Exhibit 2). Transportation has been the largest sector since 2017.

Emissions sinks, the opposite of emissions sources, absorb carbon dioxide from the atmosphere. In 2020, 13 percent of U.S. greenhouse gas emissions were offset by net sinks resulting from land use and forestry practices (Exhibit 2). One major sink is the net growth of forests, which remove carbon from the atmosphere. Other carbon sinks are associated with how people use the land, including the practice of depositing yard trimmings and food scraps in landfills. While the land use, land-use change, and forestry category represent an overall net sink of carbon dioxide in the United States, this category also includes emission sources resulting from activities such as wildfires, converting land to cropland, and biomass burning.

Total emissions and emissions per capita declined from 2007 to 2009, due in part to a drop in U.S. economic production during this time. Emissions decreased again from 2010 to 2012 and continued downward largely due to the growing use of natural gas and renewables to generate electricity in place of more carbon-intensive fuels (U.S. EPA, 2022).

Overall, with less than one-twentieth of the world's population (U.S. Bureau of the Census, 2022), the U.S. currently accounts for nearly one-seventh of total global emissions of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (WRI, 2021). For more information about emissions worldwide, see the Global Greenhouse Gas Emissions indicator in EPA's *Climate Change Indicators in the United States*.

Limitations

While this indicator addresses the major GHGs emitted by human activities, it does not include other

greenhouse gases and substances that are not covered under the United Nations Framework Convention on Climate Change but that still affect the Earth's energy balance and climate (see the Climate Forcing indicator in EPA's *Climate Change Indicators in the United States* for more details). For example, this indicator excludes ozone-depleting substances such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), which have high global warming potentials, as these gases have been or are currently being phased out under an international agreement called the Montreal Protocol. This indicator also excludes black carbon and aerosols, which most greenhouse gas emissions inventories do not cover. While there are many natural greenhouse gas emission sources, this indicator focuses on emissions that are associated with human activities—those that are most responsible for the observed buildup of these gases in our atmosphere. Although the land use, land-use change, and forestry emission estimates include emissions and sinks from unmanaged lands due to forest growth, fires, and other factors, this indicator does not include other natural sources such as methane emissions from unmanaged wetlands.

Data Sources

Data for this indicator came from EPA's *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2020* (U.S. EPA, 2022). This report is available online at: http://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.

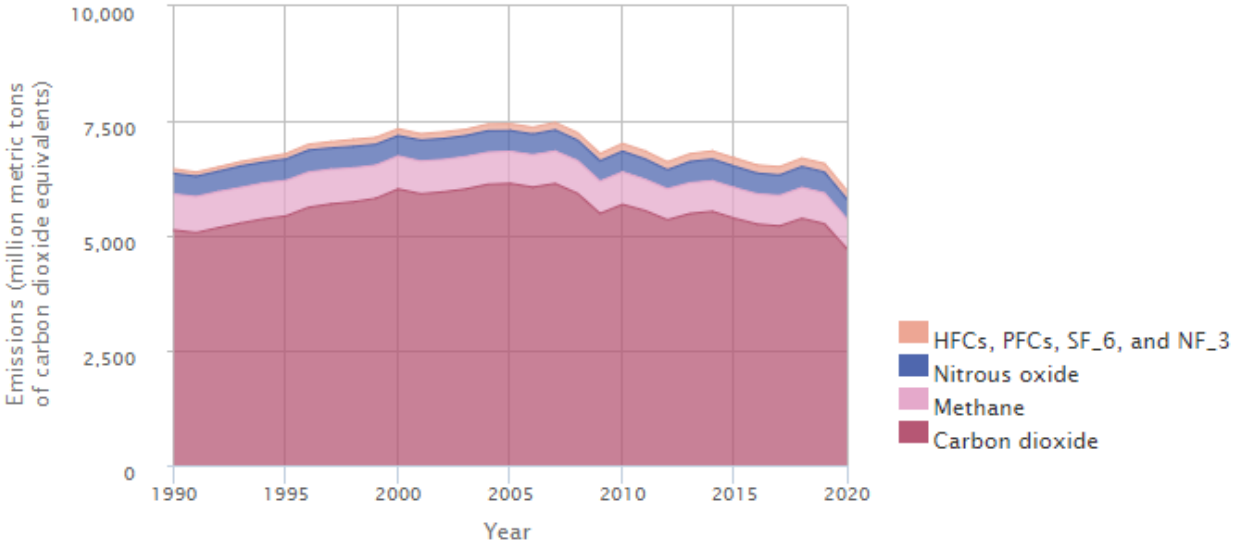
References

U.S. Bureau of the Census. 2022. U.S. and world population clocks. www.census.gov/popclock/.

U.S. EPA (U.S. Environmental Protection Agency). 2022. Inventory of U.S. greenhouse gas emissions and sinks: 1990-2020. USEPA #EPA 430-R-22-003. http://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks.

WRI (World Resources Institute). 2021. Climate Watch historical GHG emissions. Accessed March 2021. http://www.climatewatchdata.org/ghg-emissions.

Exhibit 1. Greenhouse gas emissions in the U.S. by gas, 1990–2020



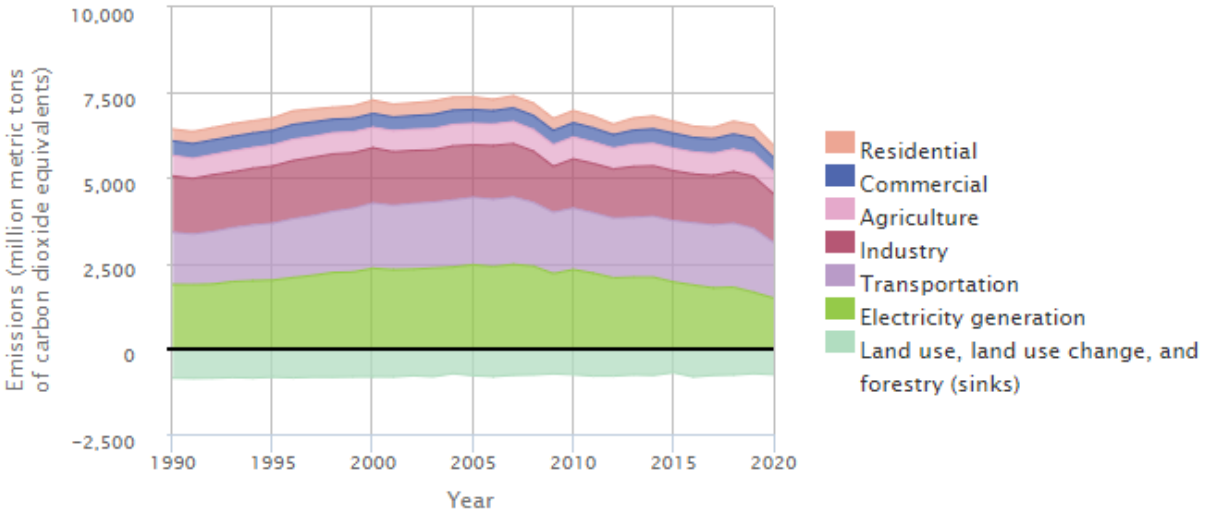
Million metric tons are the units conventionally used in greenhouse gas inventories prepared worldwide.

HFCs are hydrofluorocarbons, PFCs are perfluorocarbons, SF_6 is sulfur hexafluoride, and NF_3 is nitrogen trifluoride.

Information on the statistical significance of the trends in this exhibit is not presented here. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2022

Exhibit 2. Greenhouse gas emissions and sinks in the U.S. by economic sector, 1990–2020



Totals do not match Exhibit 1 exactly because the economic sectors shown here do not include emissions from U.S. territories.

Million metric tons are the units conventionally used in greenhouse gas inventories prepared worldwide.

Information on the statistical significance of the trends in this exhibit is not presented here. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2022