U.S. Greenhouse Gas Emissions

Q: What are the trends in greenhouse gas emissions and concentrations?

The above question pertains to all 'Greenhouse Gases' Indicators, however, the information on these pages (overview, graphics, references and metadata) relates specifically to "U.S. Greenhouse Gas Emissions". Use the right side drop list to view the other related indicators on this question.

Introduction

The Earth's climate is determined by the balance between energy received from the sun and energy emitted back to space from the Earth and its atmosphere. Certain gases in the atmosphere, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), water vapor, and others, trap some of the outgoing energy, retaining heat in the Earth's atmosphere. These are the so-called "greenhouse gases" (GHGs). The best understood GHGs emitted by human activities are CO_2, CH_4, N_2O, and certain fluorinated compounds.

Changes in GHG emissions are influenced by many long-term factors, including population and economic growth, land use, energy prices, technological changes, and inter-annual temperatures. On an annual basis, combustion of fossil fuels, which accounts for most GHG emissions in the U.S., generally fluctuates in response to changes in general economic conditions, energy prices, weather, and the availability of non-fossil alternatives (U.S. EPA, 2011).

This indicator uses data and analysis from the Inventory of U.S. Greenhouse Gas Emissions and Sinks (U.S. EPA, 2011), an assessment of the anthropogenic sources and sinks of GHG emissions for the U.S. and its territories for the 1990-2009 period. The inventory constitutes estimates derived from direct measurements, aggregated national statistics, and validated models in most source categories. An extensive discussion of the methods for determining the emissions or uptake from each source type and the uncertainties inherent in the calculations is available in U.S. EPA (2011) and its Annexes 2, 3, 4 and 7.

The indicator is expressed in terms of CO_2 equivalents, meaning that emissions of different gases are weighted by their "global warming potential" (GWP). A GWP is a measure of how much a given mass of GHG is estimated to contribute to radiative forcingwhich in turn contributes to global warmingover a selected period of time, relative to one another. Each gass GWP is determined by comparing the radiative forcing associated with emissions of that gas versus the radiative forcing associated with emissions of the same mass of CO_2, for which the GWP is set at 1. EPA is mandated to use the GWPs documented in the Intergovernmental Panel on Climate Changes Second Assessment Report (IPCC, 1996), which characterize GWPs for a 100-year time horizonthe effect of the gas on radiative forcing over 100 years. Annex 6.1 of the U.S. GHG inventory includes extensive information on GWPs and how they relate to emission estimates (U.S. EPA, 2011).

This indicator focuses on the six types of GHGs currently covered by agreements under the United Nations Framework Convention on Climate Change. These compounds are CO_2, CH_4, N_2O, selected hydrofluorocarbons (HFCs), selected perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). This indicator does not include emission estimates for substances such as chlorofluorocarbons (CFCs), methyl bromide, sulfates, black carbon, and organic carbon. These substances are excluded primarily because either their emissions have not been quantified in the U.S. GHG inventory or they have different kinds of effects on climate and therefore cannot be compared directly with the six types of GHGs included in the inventory. Combined, these excluded substances might account for a considerable portion of climate change, or offset climate change to some degree, but their omission

cannot be scientifically quantified in comparable terms.

This indicator presents emission data in units of teragrams of CO_2 equivalents (Tg CO_2 Eq). These units are conventionally used in GHG inventories prepared worldwide. For reference, one teragram (Tg) is equal to one million metric tons.

What The Data Show

In 2009, the United States emitted 6,633 Tg CO_2 Eq of GHGs, up 7 percent from 1990 (Exhibit 2-50). CO_2 is the primary GHG emitted by human activities, and it accounted for 83 percent of U.S. GHG emissions in 2009. CH_4 and N_2O are the next largest components, representing 10 percent and 4 percent of total U.S. GHG emissions in 2009, respectively. The primary sources of CH_4 emissions include enteric fermentation in domestic livestock, decomposition of wastes in landfills, releases from natural gas systems, coal mine seepage, and manure management. The main anthropogenic activities producing N_2O are agricultural soil management, fuel combustion in motor vehicles, nitric acid production, manure management, and stationary fuel combustion. HFCs, PFCs, and SF_6 account for the remainder of emissions considered in the inventory report. Despite being emitted in smaller quantities than the other principal GHGs, HFCs, PFCs, and SF_6 are important because many of them have extremely high GWPs and, in the cases of PFCs and SF_6, atmospheric lifetimes of 700 to 50,000 years.

Between 1990 and 2009, emissions of CO_2 increased by 405 Tg CO_2 Eq (8 percent) (Exhibit 2-50).CH_4 emissions increased by 2 percent during the same period, while N_2O emissions declined by 6 percent (U.S. EPA, 2011). Total GWP-weighted emissions of HFCs, PFCs, and SF_6 increased by 59 percent from 1990 to 2009.

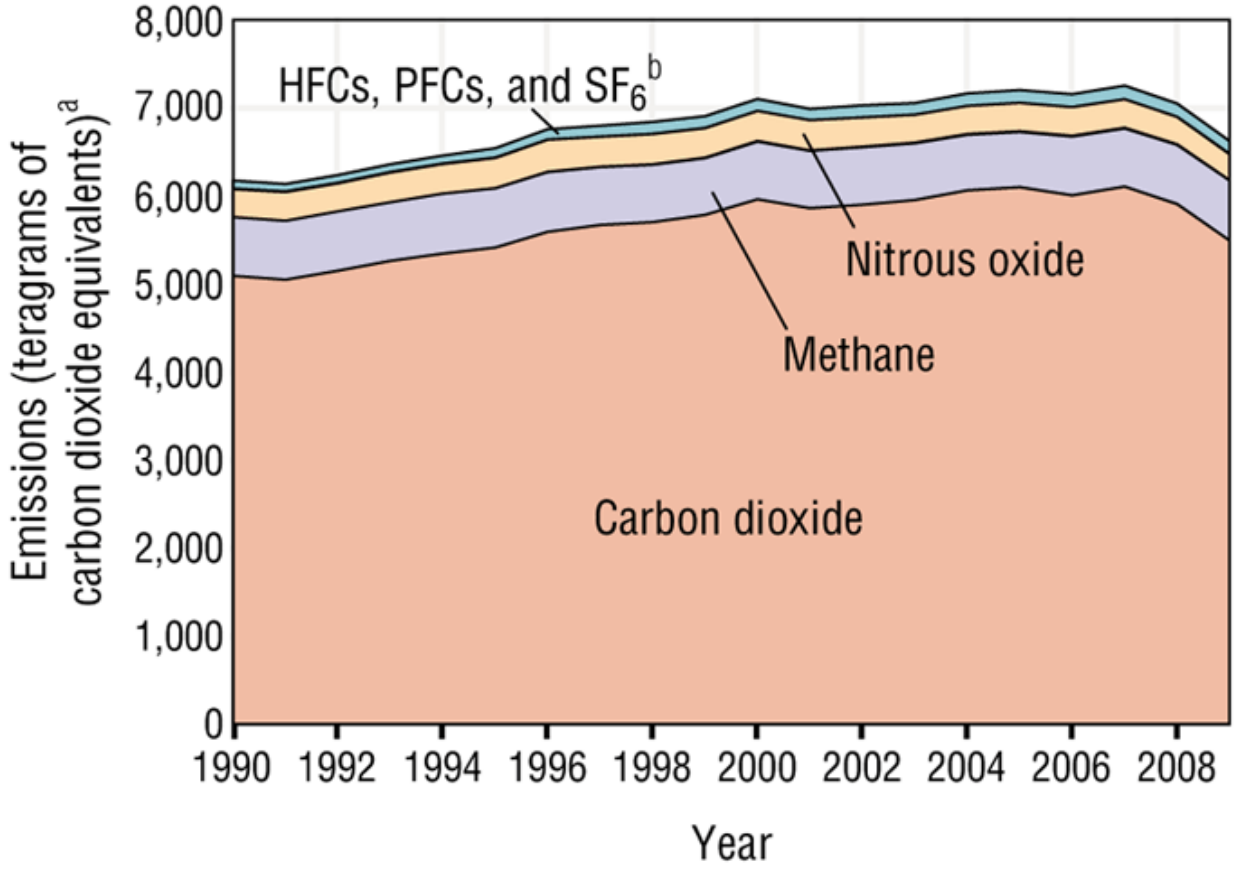
GHG emissions by economic sector show that energy-related activities account for a majority of U.S. emissions (Exhibit 2-51). Electricity generation is the largest single source, accounting for 32 percent of all U.S. GHG emissions since 1990. Transportation is the second largest source (27 percent since 1990), followed by industrial activities. The agricultural, commercial, and residential sectors account for the remainder of emissions. The totals for these sectors include emissions due to fuel combustion (e.g., heating buildings), farming practices, waste generation, and various other activities. Emissions from industry have decreased by 15 percent since 1990, reflecting improved energy efficiency, the switch to less carbon-intensive fuels, and the shift from a manufacturing-based economy to a service-based economy (U.S. EPA, 2011).

U.S. GHG emissions are partly offset by uptake of carbon and “sequestration” in forests, trees in urban areas, agricultural soils, and landfilled yard trimmings and food scraps. In aggregate, these removals of CO_2 from the atmosphere offset about 15 percent of total U.S. GHG emissions in 2009 (Exhibit 2-51).

Despite long-term increases in GHG emissions from 1990 to 2009, emissions decreased between 2007 and 2009 (Exhibits 2-50 and 2-51). This decline was seen for all gases except methane and across all sectors except commercial and residential activities, where direct emissions increased slightly. The decrease in emissions can largely be attributed to lowered energy use due to the economic downturn and to fuel switching from coal to natural gas—a less carbon intensive fuel—as the cost of natural gas decreased compared with the cost of coal (U.S. EPA, 2011).

Overall, with less than one-twentieth of the world's population (U.S. Bureau of the Census, 2011), the U.S. currently accounts for nearly one-fifth of total global emissions of CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6 (World Resources Institute, 2011).

Exhibit 2-50. Greenhouse gas emissions in the U.S. by gas, 1990-2009

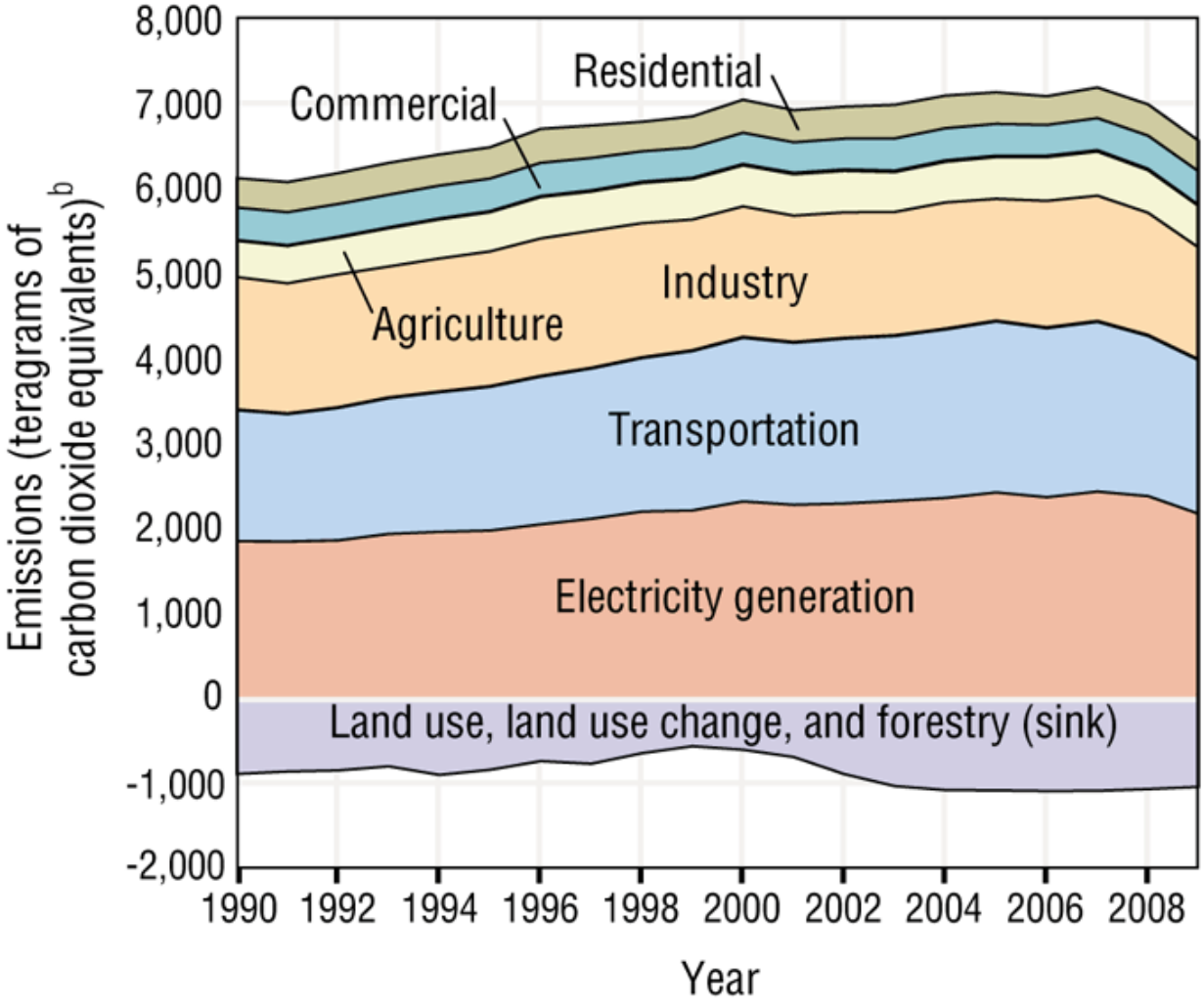


[a]Teragrams of carbon dioxide equivalents are the units conventionally used in greenhouse gas inventories prepared worldwide. For reference, one teragram equals one million metric tons.

[b]HFCs are hydrofluorocarbons, PFCs are perfluorocarbons, and SF_6 is sulfur hexafluoride.

Data source: *U.S. EPA, 2011*

Exhibit 2-51. Greenhouse gas emissions in the U.S. by economic sector, 1990-2009[a]



[a]Totals do not match Exhibit 2-50 exactly because the economic sectors shown here do not include emissions from U.S. territories.

[b]Teragrams of carbon dioxide equivalents are the units conventionally used in greenhouse gas inventories prepared worldwide. For reference, one teragram equals one million metric tons.

Data source: *U.S. EPA, 2011*

Limitations

- This indicator does not yet include emissions of GHGs or other radiatively important substances that are not explicitly covered by the United Nations Framework Convention on Climate Change and its subsidiary protocol. Thus, it excludes such gases as those controlled by the Montreal Protocol and its Amendments, including CFCs and hydrochlorofluorocarbons. Although the U.S. reports the emissions of these substances as part of the U.S. GHG inventory (see Annex 6.2 of the U.S. GHG inventory), the origin of the estimates is fundamentally different from those of the other GHGs and therefore cannot be compared directly with the other emissions discussed in this indicator.

- This indicator does not include aerosols and other emissions that affect radiative forcing but are not well-mixed in the atmosphere, such as sulfur dioxide (see Annex 6.3 of the U.S. GHG inventory), ammonia, black carbon, and organic carbon. Emissions of these compounds can be highly uncertain and have qualitatively different effects than the six types of emissions in this indicator.

- This indicator does not include emissions of other compounds—such as carbon monoxide, nitrogen oxides, nonmethane volatile organic compounds, and substances that deplete the stratospheric ozone layer—which indirectly affect the Earth's radiative balance (for example, by altering GHG concentrations, changing the reflectivity of clouds, or changing the distribution of heat fluxes).

- The U.S. GHG inventory does not account for "natural" emissions of GHGs, such as from wetlands, soils, oceans, termites, and volcanoes. These excluded sources are discussed in Annex 5 of the U.S. GHG inventory (U.S. EPA, 2011). The U.S. GHG inventory does include, in its "land use, land use change, and forestry" category, emissions from changes in the forest inventory due to fires, harvesting, and other activities, and from agricultural soils.

Data Sources

The data used for this indicator were published in EPA's inventory of greenhouse gas emissions and sinks for the years 1990-2009 (U.S. EPA, 2011). Emissions by gas (Exhibit 2-50) are taken from Table ES-2 of the inventory report, and emissions by economic sector (Exhibit 2-51) are taken from Table ES-7.

References

IPCC (Intergovernmental Panel on Climate Change). 1996. Climate change 1995: The science of climate change. Cambridge, United Kingdom: Cambridge University Press.

U.S. Bureau of the Census. 2011. U.S. and world population clocks. http://www.census.gov/main/www/popclock.html

U.S. EPA (United States Environmental Protection Agency). 2011. Inventory of U.S. greenhouse gas emissions and sinks: 1990-2009.

http://www.epa.gov/climatechange/emissions/usinventoryreport.html

World Resources Institute. 2011. Climate Analysis Indicators Tool (CAIT). Version 8.0. Accessed April 2011. http://cait.wri.org/