



URBAN GREENHOUSE GAS INVENTORY SPECIALIST TRAINING COURSE

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GHG AND CLIMATE CHANGE SPECIALIST CURRICULUM





GHGS AND GLOBAL WARMING POTENTIAL

FOR GHG & CLIMATE CHANGE PROFESSIONALS
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LEARNING OBJECTIVES



- The 7 main greenhouse gas categories
- GHGs and Global Warming Potential
- GHG emission sources in the context of entity-level operations,
- What an entity-level GHG inventory is and how it relates to other types of GHG emissions accounting,



THE GREENHOUSE GASES -CARBON DIOXIDE (CO₂)

In nature, carbon is cycled between various atmospheric, oceanic, land biotic, marine biotic, and mineral reservoirs (e.g., limestone). The largest fluxes of CO₂ occur between the atmosphere and terrestrial biota, and between the atmosphere and surface water of the oceans. In the atmosphere, carbon predominantly exists in its oxidized form as CO₂.

Atmospheric carbon dioxide is part of this global carbon cycle, and therefore its fate is a complex function of geochemical and biological processes. Carbon dioxide concentrations in the atmosphere increased from approximately 280 parts per million by volume (ppmv) in pre-industrial times to 380 ppmv today.

The IPCC notes that "[t]his concentration has not been exceeded during the past 420,000 years, and likely not during the past 20 million years. The rate of increase over the past century is unprecedented, at least during the past 20,000 years." The IPCC definitively states that "the present atmospheric CO₂ increase is caused by human-caused emissions of CO₂" (IPCC 2001). Forest clearing, other biomass burning, and some non-energy production processes (e.g., cement production) also emit notable quantities of carbon dioxide.



METHANE (CH₄)

Methane is primarily produced through anaerobic (i.e., without oxygen) decomposition of organic matter in biological systems. Agricultural processes such as wetland rice cultivation, enteric fermentation in animals (i.e., burps and farts), and the decomposition of animal wastes emit CH₄, as does the decomposition of trash.

Methane is also emitted during the production and distribution of natural gas and petroleum, and is released as a by-product of coal mining and incomplete fossil fuel combustion. Atmospheric concentrations of methane have increased by about 150 percent since pre-industrial times.



NITROUS OXIDE (N₂O)

Anthropogenic sources of N₂O emissions include agricultural soils, especially the use of fertilizers; fossil fuel combustion, especially from mobile combustion; industrial adipic (nylon) and nitric acid production; wastewater treatment and waste combustion; and biomass burning.

The atmospheric concentration of nitrous oxide (N₂O) has increased by 18 percent since 1750, a concentration that has not been exceeded during the last thousand years.



HALO-FLUOROCARBONS, PERFLUOROCARBONS, AND SULFUR HEXAFLUORIDE (SF6)

Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) are powerful greenhouse gases. HFCs—primarily used as replacements for ozone depleting substances but also emitted as a by-product of the HCFC-22 manufacturing process—currently have a small global impact; however, it is anticipated that their emissions will increase in the future.

PFCs and SF6 are predominantly emitted from various industrial processes (including aluminum smelting, semiconductor manufacturing, electric power transmission and distribution, and magnesium casting). Currently, the global impact of PFCs and SF6 is also small; however, they have a significant growth rate, extremely long atmospheric lifetimes, and are strong absorbers of infrared radiation, and therefore have the potential to influence climate far into the future (IPCC 2001).

Nitrogen Trifluoride Now Required in GHG Protocol Greenhouse Gas Emissions Inventories

One recent example concerns the greenhouse gas (GHG) nitrogen trifluoride (NF3), a chemical that is released in some high-tech industries, including in the manufacture of many electronics. The GHG Protocol now requires NF3 to be included in GHG inventories under the Corporate Standard, Value Chain (Scope 3) Standard, and Product Standard. A new GHCP Amendment updates the existing requirements.

GHGS AND GLOBAL WARMING POTENTIAL

Because GHGs vary in their ability to trap heat in the atmosphere, some are more harmful to the climate than others. Each GHG has a "global warming potential" (GWP), which refers to its heat-trapping ability relative to that of CO2. For example, methane is 21 times more potent than CO2, so methane has a GWP of 21.

GHG	GWP
CO2	1
CH4	21
N2O	310
HCFCs	140 - 11,700
PFCs	6,500 - 9,200
SF6	23,900

The GWPs shown in the table to the right are 100-year GWPs, referring to their effect relative to CO2 over a 100- year timeframe. Source: U.S. Environmental Protection Agency, Greenhouse Gases and Global Warming Potential Values, 2002.

GLOBAL WARMING POTENTIAL

Global Warming Potentials (GWPs) are intended as a quantified measure of the globally averaged relative radiative forcing impacts of a particular greenhouse gas. It is defined as the cumulative radiative forcing—both direct and indirect effects—integrated over a period of time from the emission of a unit mass of gas relative to some reference gas (IPCC 1996). Carbon dioxide (CO2) was chosen as this reference gas.

Direct effects occur when the gas itself is a greenhouse gas. Indirect radiative forcing occurs when chemical transformations involving the original gas produce a gas or gases that are greenhouse gases, or when a gas influences other radiatively important processes such as the atmospheric lifetimes of other gases.

GLOBAL WARMING POTENTIAL +

The relationship between gigagrams (Gg) of a gas and Tg CO₂ Eq. can be expressed as follows:

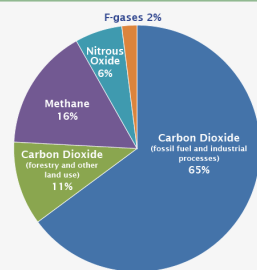
$$Tg\ CO_2e = (Gg\ of\ gas) \times (GWP) \times (Tg / 1000\ Gg)$$

Where: Tg CO₂e = Teragrams of Carbon Dioxide Equivalents
Gg = Gigagrams (equivalent to a thousand metric tons) GWP = Global Warming Potential Tg = Teragrams

GWP values allow policy makers to compare the impacts of emissions and reductions of different gases. According to the IPCC, GWPs typically have an uncertainty of roughly ±35 percent, though some GWPs have larger uncertainty than others, especially those in which lifetimes have not yet been ascertained.

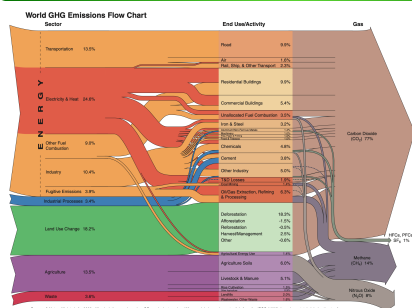
GLOBAL GHGS BY CO₂-EQUIVALENT

Global Greenhouse Gas Emissions by Gas



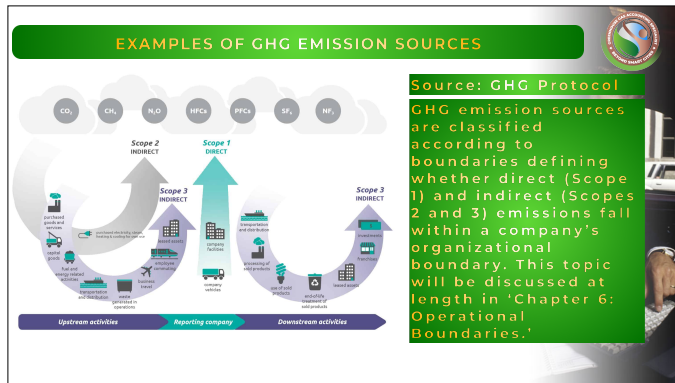
Each GHG can be expressed in CO₂-equivalents, which is equal to the quantity of GHG (for example in tons) multiplied by its GWP. The pie chart shown here identifies global GHG emissions for the year 2000 by CO₂-equivalent.

GHG FLOW DIAGRAM: GLOBAL GREENHOUSE GAS EMISSIONS



Source: World Resources Institute, Navigating the Numbers, 2005.

At the sector level, the largest contributors to global GHG emissions are electricity and heat, land-use change and forestry, transport, and agriculture. This figure also shows emissions by activity, or end use, in the middle column. Viewed this way, the largest emissions come from road transport, residential buildings, oil and gas production, agricultural soils, chemicals/petrochemicals,



GHG ACCOUNTING

GHG accounting attempts to quantify and organize information about GHG emissions based on common standards and protocols, and to attribute emissions correctly to a facility, company, nation, or other entity.

This course focuses specifically on corporate- or entity-level GHG accounting, which is the basis for developing a company's or organization's GHG inventory and developing a GHG management strategy.

You may also be familiar with terms such as GHG offsets and carbon neutrality. These terms relate to project-level GHG accounting and are not addressed in detail in this course.

GHG offsets: GHG offsets are discrete GHG reductions used to compensate for (i.e., offset) GHG emissions elsewhere, for example to meet a voluntary or mandatory carbon cap. Offsets are calculated relative to a baseline that represents a hypothetical scenario for what emissions would have been in the absence of any consideration of GHG reductions.

Carbon neutrality – "Carbon neutrality" refers to reducing or offsetting the carbon impact of a given entity, product, or activity so that it results in no net carbon emissions to the atmosphere.

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