

Emission Facts

Metrics for Expressing Greenhouse Gas Emissions: Carbon Equivalents and Carbon Dioxide Equivalents

The U.S. Environmental Protection Agency (EPA) developed this series of four fact sheets to facilitate consistency of assumptions and practices in the calculation of emissions of greenhouse gases from transportation and mobile sources. They are intended as a reference for anyone estimating emissions benefits of mobile sources air pollution control programs.

Global warming potentials and the use of a common metric

Emissions of greenhouse gases are typically expressed in a common metric, so that their impacts can be directly compared, as some gases are more potent (have a higher global warming potential or GWP) than others.

The international standard practice is to express greenhouse gases in carbon dioxide (CO₂) equivalents. Emissions of gases other than CO₂ are translated into CO₂ equivalents using global warming potentials. The Intergovernmental Panel on Climate Change (IPCC) recommends using 100 year potentials.

These potentials¹ are:

	GWP
Carbon dioxide (CO ₂)	1
Methane (CH ₄)	21
Nitrous oxide (N ₂ O)	310
Hydrofluorocarbon (HFC)-134a (used in mobile source air conditioning)	1,300

Carbon dioxide equivalents vs. carbon equivalents

While the international standard is to express emissions in CO₂ equivalents (CO₂e), many U.S. sources have expressed emissions data in terms of carbon equivalents (CE) in the past. In particular, EPA has used the carbon equivalent metric in the past for budget documents. The benefits of voluntary programs have often been expressed in million metric tons of carbon equivalent (MMTCE). Essentially, this practice accounts for the carbon in the CO₂ molecule, as opposed to counting the entire molecule.

EPA's Office of Transportation and Air Quality (OTAQ) uses the CO₂ equivalent metric for calculating the national inventory for greenhouse gas emissions, and is moving towards using the CO₂ metric to characterize the benefits of its voluntary programs to be consistent with international practice. Emission reductions from voluntary programs will generally be expressed in million metric tons of CO₂ equivalent. For the purposes of national greenhouse gas inventories, emissions are expressed as teragrams of CO₂ equivalent (Tg CO₂ Eq). One teragram is equal to 10¹² grams, or one million metric tons.

¹ These estimates are from the IPCC's "Second Assessment Report" (1996). These are the values used internationally for reporting greenhouse gas (GHG) emissions to the United Nations. (EPA also uses them for the "Inventory of U.S. Greenhouse Gas Emissions and Sinks.") The IPCC has since published the "Third Assessment Report" (2001) and has updated GHG potential values. These are 23 for CH₄, 296 for N₂O, and 1,300 for HFC-134a. These values, however, have not yet been adopted by EPA for the purpose of developing inventories.

Converting between carbon dioxide equivalents and carbon equivalents

The conversion between CO₂e and CE is directly related to the ratio of the atomic mass of a carbon dioxide molecule to the atomic mass of a carbon atom (44:12).

To convert from CE to CO₂e, multiply by 44/12

For example, 6 million metric tons of carbon equivalent (6 MMTCE) = 6 x (44/12) = 22 million metric tons of CO₂ equivalent.

1 metric ton carbon equivalent = 3.667 metric tons of CO₂ equivalent.

To convert from CO₂e to CE, multiply by 12/44

For example, 11 million metric tons of CO₂ equivalent = 11 x (12/44) = 3 million metric tons of carbon equivalent (3 MMTCE).

1 metric ton of CO₂ equivalent = 0.2727 metric tons of carbon equivalent.

For More Information

You can access documents on greenhouse gas emissions on the Office of Transportation and Air Quality Web site at:

www.epa.gov/otaq/greenhousegases.htm

For further information on calculating emissions of greenhouse gases, please contact Ed Coe at:

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