A Closer Look at Greenhouse Gases

When energy is sent from the sun, the shorter wavelengths, such as ultraviolet and visible light, pass through the atmosphere and strike the surface of the Earth. The atmosphere and objects on the Earth's surface absorb this radiation. Much of this radiation is transformed into thermal energy and the infrared energy is radiated back from the surface of the Earth and some of it into space. The reason that much of the heat is contained within our atmosphere is due to the properties of greenhouse gases. The atmosphere is composed mostly of nitrogen and oxygen. The bonding structures of nitrogen gas (triple bonded) and oxygen (double bonded) do not have a great deal of flexibility with the bending and stretching of their bonds. The greenhouse gases, such as carbon dioxide, methane, water vapor, and nitrous oxide, have a great deal of flexibility in the vibrating, stretching, and bending of their bonds. Therefore, as the molecules are exposed to infrared radiation, the bonds within these molecules have a great deal of potential to absorb that energy. This increases the kinetic energy of these molecules and raises the internal heat in the molecules, which can then be transmitted to other atmospheric gases to increase the temperature of the atmosphere, and therefore the temperature of the surface of the Earth.

▪ Carbon Dioxide

Just over eighty percent of U.S. greenhouse gas emissions come in the form of carbon dioxide. Historically, natural levels of CO_2 in the atmosphere have been governed by the cycling of carbon that occurs between Earth's four systems. Today only five percent of atmospheric CO_2 levels are attributed to natural processes. Ninety-five percent of CO_2 emissions come from human activity—the **combustion** of fossil fuels in electricity generation, transportation, industrial, commercial, and residential uses.

▪ Methane

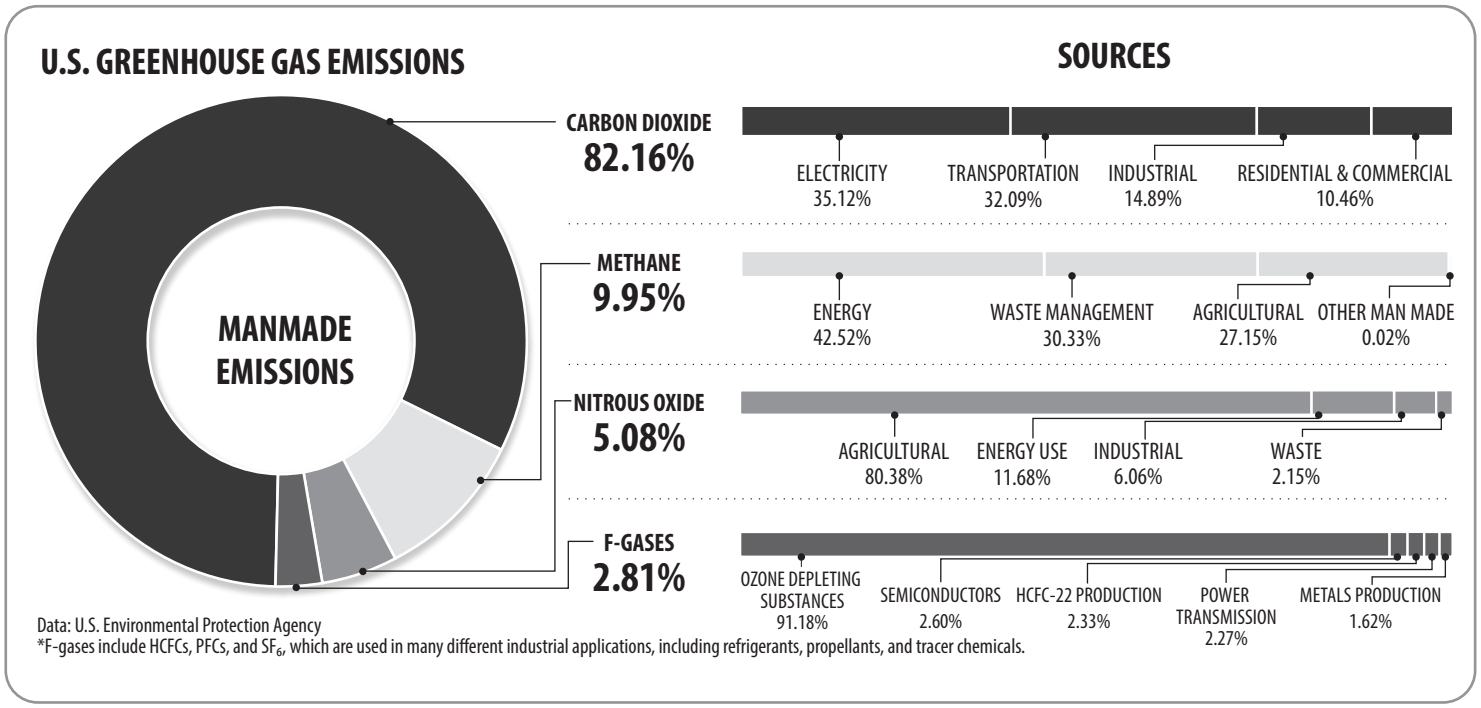
Methane is not as abundant in the atmosphere as CO_2; it makes up about 10 percent of greenhouse gas emissions, but it is 20 times more effective at trapping heat than CO_2. However, methane has a short lifespan, breaking down in the atmosphere after approximately 12 years. In the last 250 years, CH_4 concentrations have risen 160 percent. Methane emissions come from enteric fermentation (the digestive process of livestock), decomposition of waste in landfills, solid waste, producing and burning fossil fuels, biomass burning, and rice cultivation.

▪ Nitrous Oxide

Nitrous oxide makes up about 5 percent of the U.S. greenhouse gas emissions, yet N_2O is over 300 times more powerful than carbon dioxide at trapping heat. N_2O is naturally released into the atmosphere from natural processes in the soil and ocean. However, current agricultural practices release high levels of N_2O from the soil, as does fuel combustion in motor vehicles.

▪ Water Vapor

Climatologists who have been analyzing greenhouse gases have found that water vapor is the most abundant GHG, accounting for two-thirds of all heat trapped in the atmosphere. Constantly moving between the hydrosphere, atmosphere, and biosphere, water vapor is a key player in the climate picture. Some scientists believe that rising atmospheric temperatures around the world may allow the atmosphere to hold more water vapor, which might, in turn, lead to more warming. However, water vapor levels have remained relatively constant through history, so it does not appear that increased water vapor is responsible for the changing climate.



Data: U.S. Environmental Protection Agency

*F-gases include HCFCs, PFCs, and SF_6, which are used in many different industrial applications, including refrigerants, propellants, and tracer chemicals.