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HFCs: A Critical Link in Protecting Climate and the Ozone Layer

A UNEP Synthesis Report

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Contents

Glossary

Article 5 Countries: Any party of the Montreal Protocol who is a developing country and whose annual per capita consumption of the controlled substances is below the limits set in Article 5 of the Protocol.

Atmospheric lifetime: Time it takes for 67% of a molecules to be removed from the atmosphere in the absence of emissions.

Atmospheric mixing ratio: The fractional composition of a chemical in the atmosphere relative to the sum of all air molecules in the atmosphere.

The mixing ratio of a chemical is the number of molecules of X in a unit volume divided by the number of air molecules in a unit volume. Mixing ratios are usually expressed as parts-per-million (ppm), parts-per-billion (ppb), or parts-per-trillion (ppt).

Carbon dioxide equivalent (CO_2eq): A simple way to place emissions of various climate change agents on a common footing to account for their effect on climate.

A quantity that describes, for a given mixture and amount of greenhouse gas, the amount of carbon dioxide that would have the same global warming ability, when measured over a specified timescale.

Chlorofluorocarbons (CFCs): Molecules containing carbon, fluorine, and chlorine. CFCs are the major ozone depleting substances already phased out by the Montreal Protocol. Many CFCs are potent greenhouse gases.

Drop-in alternatives: Substances that can be used in existing equipment with very little or no modification to the equipment. Drop-in replacements were used to quickly replace CFCs. Examples include use of HCFC-22 in air conditioners. Such replacements are also possible with some HFCs.

Global Warming Potential (GWP): A relative index that enables comparison of the climate effect of the emissions of various greenhouse gases (and other climate changing agents). Carbon dioxide, the greenhouse gas that causes the greatest radiative forcing because of its overwhelming abundance, is chosen as the reference gas.

GWP is also defined as an index based on the radiative forcing of a pulsed injection of a unit mass of a given well-mixed greenhouse gas in the present-day atmosphere, integrated over a chosen time horizon, relative to the radiative forcing of carbon dioxide over the same time horizon. The GWPs represent the combined effect of the differing atmospheric lifetimes (i.e., how long these gases remain in the atmosphere) and their relative effectiveness in absorbing outgoing thermal infrared radiation. The Kyoto Protocol is based on GWPs from pulse emissions over a 100-year time frame.

20-year GWP: Global warming potential (see above) calculated for a time horizon of 20 years.

***100-year GWP*:** Global warming potential (see above) calculated for a time horizon of 100 years.

GWP Weighting: A mathematical product of the emissions in tonnes and the GWP of a substance. GWP weighting is used routinely to evaluate the relative climate impact of emissions of various gases (by mass).

Hydrochlorofluorocarbons (HCFCs): Chemicals that contains hydrogen, fluorine, chlorine, and carbon. They do deplete the ozone layer, but have less potency compared to CFCs. Many HCFCs are potent greenhouse gases.

Hydrofluorocarbons (HFCs): Chemicals that contains hydrogen, fluorine, and carbon. They do not deplete the ozone layer and have been used as substitutes for CFCs and HCFCs. Many HFCs are potent greenhouse gases.

Indirect climate effects: A metric that accounts for climate effects caused by the use of a product, such as increased energy consumption.

Additional climate forcing due to the energy used, or saved, during the application or product lifetime, as well as the energy used to manufacture the product, and any ODSs or HFCs used. For example, insulating foam products in buildings and appliances reduces energy consumption, whereas refrigeration and air-conditioning systems consume energy over their lifetimes. Analyses of the total potential climate impact of specific products can be estimated by life cycle climate performance (LCCP) or similar models that account for all direct and indirect contributions.

Indirect radiative forcing: A metric that accounts for effects on the climate system of a given agent as a result of changes induced in other climate forcing agents. For example, the climate effects of ozone layer depletion caused by ODSs.

In this report, indirect radiative forcing refers to the change in ozone radiative forcing due to the addition of ODSs. Stratospheric ozone losses are generally thought to cause a negative radiative forcing, cancelling part of the increased radiative forcing arising from the direct influence of the halocarbons. The magnitude of the indirect effect is strongly dependent on the altitude profile of the halogen-induced ozone loss and will vary depending on the source gas considered.

Intervention scenarios: A scenario where action is taken to change the amount of emissions of a given chemical.

Non-article 5 countries: Developed countries.

Not-in-kind alternatives: Products or technologies not using halocarbons. Not-in-kind alternative technologies achieve the same product objective without the use of halocarbons, typically by using an alternative approach or unconventional technique. Examples include the use of stick or spray pump deodorants to replace CFC-12 aerosol deodorants; the use of mineral wool to replace CFC, HFC or HCFC insulating foam; and the use of dry powder inhalers (DPIs) to replace CFC or HFC metered dose inhalers (MDIs).

Ozone Depletion Potential (ODP): A measure of the extent of ozone layer depletion by a given ozone depleting substance, relative to that depleted by CFC-11. (CFC-11 has an ODP of 1.0).

There are many variants of ODPs. In this report, we use only the steady-state ODP, which is used by the Montreal Protocol. Steady-state ODP is defined by the time-integrated change of global ozone due to a unit mass emission of the ODS at the Earth's surface, relative to that from a similar emission of a unit mass of CFC-11.

Radiative Forcing: A measure of how a climate forcing agent influences the energy balance of Earth, with a positive value indicating a net heat gain to the lower atmosphere, which leads to a globally average surface temperature increase, and a negative value indicating a net heat loss.

Radiative forcing is the instantaneous change in the net, downward minus upward, irradiance (expressed in $W\ m^{-2}$) at the tropopause due to a change in an external driver of climate change, such as, a change in the concentration of a greenhouse gas (e.g., carbon dioxide), land use change, or the output of the Sun. Radiative forcing is computed with all tropospheric properties held fixed at their unperturbed values, and after allowing for stratospheric temperatures, if perturbed, to readjust to radiative-dynamical equilibrium.

Short-lived climate forcers: Substances (mainly chemicals) that influence climate but whose influence is quickly reduced once their emissions cease. These molecules are quickly removed from the atmosphere.

Stratospheric ozone: Ozone (O_3) present in the stratosphere located between roughly 15 and 45 km above Earth's surface.

Transitional substitute: Substitutes for CFCs, Halons, and few other ODSs that were introduced with the idea