

# The large contribution of projected HFC emissions to future climate forcing

Published by Guus J. M. Velders, David W. Fahey, John S. Daniel, Mack McFarland, Stephen O. Andersen in the *Proceedings of the National Academy of Sciences*, 106, June 2009

**1. Strong growth is projected to occur through 2050 in the global demand for hydrofluorocarbons (HFCs).** The global phaseout of CFCs, halons, and hydrochlorofluorocarbons (HCFCs) will leave much of the application demand for refrigeration, air conditioning, heating and thermal-insulating foam production to be met by HFCs. The demand for HFCs is therefore expected to increase globally, but especially in the developing world (mainly Asia), in the absence of new regulations. The HFC consumption and emissions in developing countries are projected to be as much as 800% greater than in developed countries in 2050. →

**2. New HFC emissions scenarios now update previous estimates from the Intergovernmental Panel on Climate Change (IPCC).** New baseline scenarios are derived from gross domestic product (GDP) and population growth and incorporate new information from:

- increased HCFC consumption in developing countries,
- atmospheric observations of HCFCs and HFCs,
- patterns of replacements of HCFCs by HFCs,
- provisions of the 2007 accelerated HCFC phaseout,
- increases in HFC-134a use in mobile air-conditioning,
- saturation of HFC consumption in developing countries at levels found in developed countries in 2020.

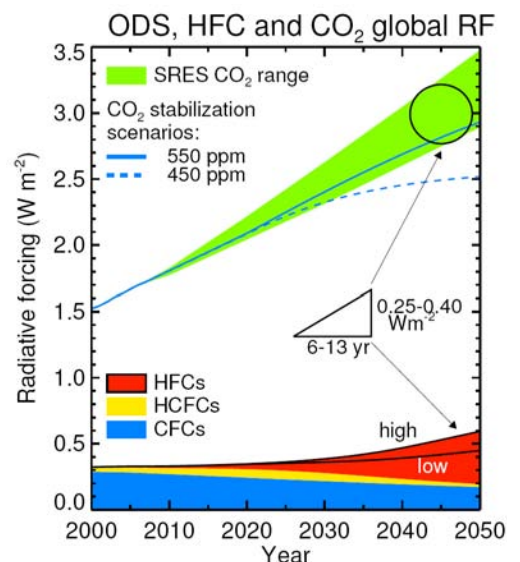
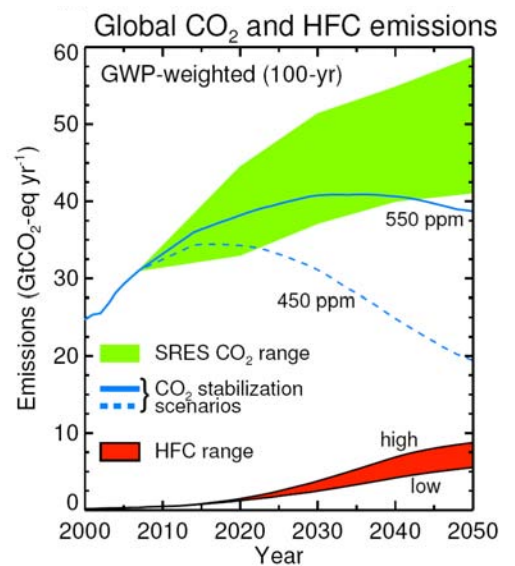
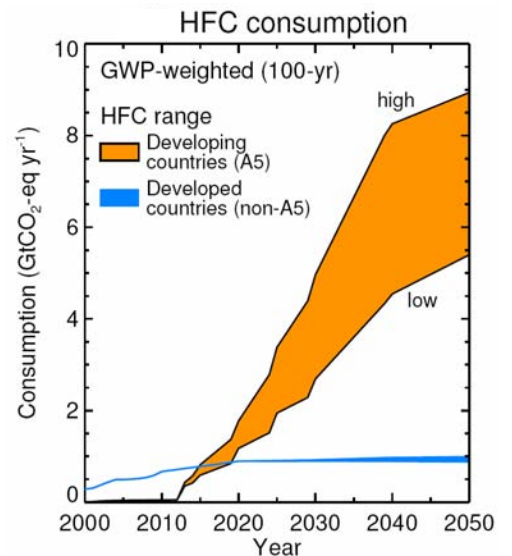
**Background: HFCs**

HFCs do not deplete the ozone layer but, along with CFCs and HCFCs, are greenhouse gases which contribute to the radiative forcing of climate. The GWPs (100-yr) of principal HFCs are:

HFC-125 = 3,500; HFC-134a = 1,430; HFC-143a = 4,470

**3. Global HFC emissions in 2050 are projected to be 5.5–8.8 GtCO<sub>2</sub>-eq yr<sup>-1</sup> which is equivalent to 9–19% of projected global CO<sub>2</sub> emissions in business-as-usual scenarios.** Global HFC emission projections increase strongly after 2013 and significantly exceed previous estimates after 2025. Estimates incorporate 100-yr GWP values to weigh individual HFCs in formulating the total emission values. →

**4. Global radiative forcing from projected HFC emissions in 2050 are equivalent to that from 6–13 years of CO<sub>2</sub> emissions.** The HFCs contribute a radiative forcing of 0.25–0.40 W m<sup>-2</sup> in 2050 compared to CO<sub>2</sub> values of 2.9–3.5 W m<sup>-2</sup>. →



Contact information: G. Velders (PBL, Netherlands) guus.velders@pbl.nl; D. Fahey (NOAA/ESRL, USA) david.w.fahey@noaa.gov; J. Daniel (NOAA/ESRL, USA) john.s.daniel@noaa.gov; M. McFarland (DuPont Fluoroproducts, USA) mack.mcfarland@usa.dupont.com; S. Andersen (EPA, USA) andersen.stephen@epa.gov.

**Background: Montreal Protocol**

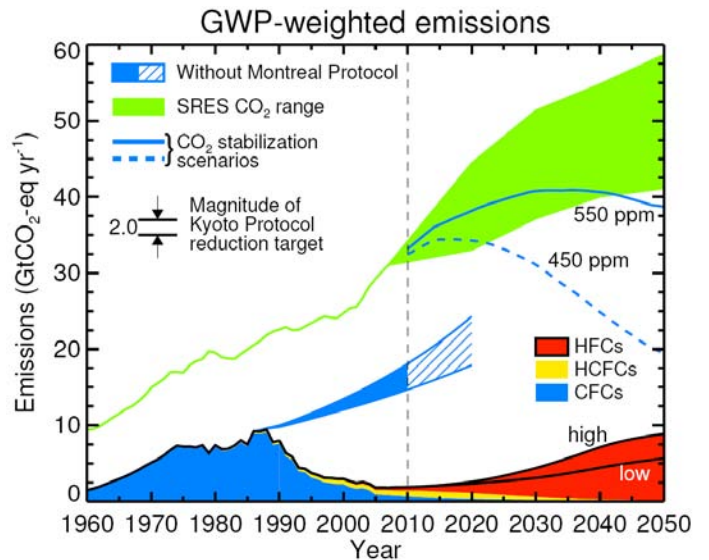
- The Montreal Protocol has reduced the global consumption of chlorofluorocarbons (CFCs) by more than 95% from its peak value. CFCs are principal ozone depleting substances (ODSs). As a result, the consumption of HCFCs as substitute compounds has increased. In developing countries the increase is 20% yr<sup>-1</sup> (in agreement with new observations).
- With the 2007 accelerated HCFC phaseout, the consumption of HCFCs should be virtually zero in developed countries by 2020 and in developing countries by 2030.

**5. HFC emissions in 2050 will largely offset the climate benefits already achieved by the Montreal Protocol in terms of annual emissions reductions.**

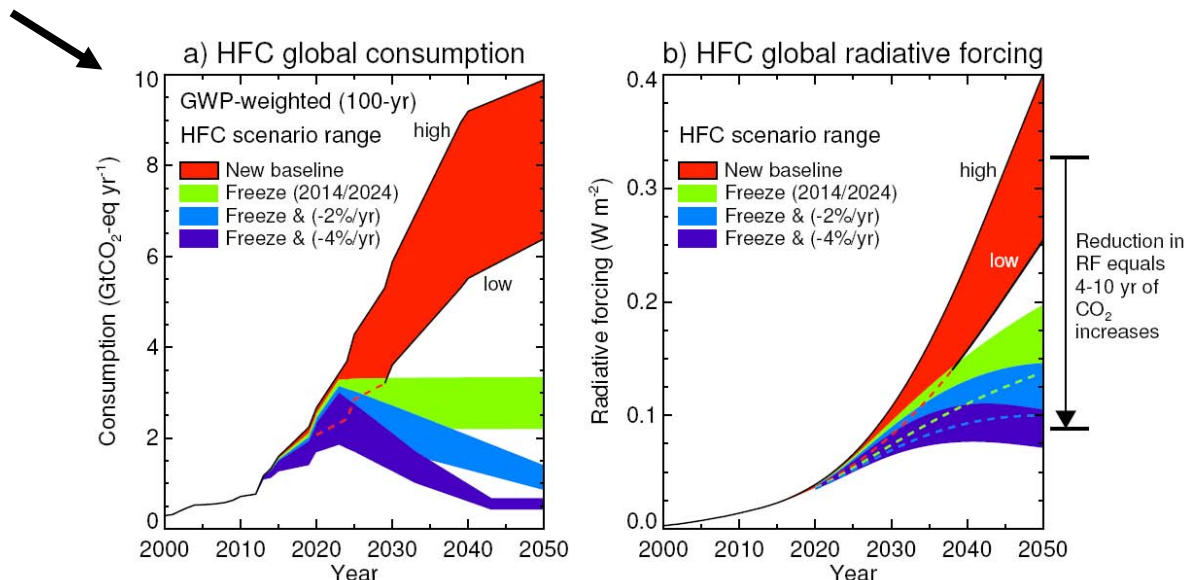
HFC emissions are projected to reach 5.5–8.8 GtCO<sub>2</sub>-eq yr<sup>-1</sup> in 2050. In comparison, ODS emissions peaked at 9.4 GtCO<sub>2</sub>-eq yr<sup>-1</sup> in 1988 and could have reached 15–18 GtCO<sub>2</sub>-eq yr<sup>-1</sup> in 2010 in the absence of Montreal Protocol regulations. ➔

**Background: CO<sub>2</sub>-equivalence**

The contributions to climate forcing from different greenhouse-gas emissions can be compared by scaling the emissions with the associated global warming potentials (GWPs) to form 'CO<sub>2</sub>-equivalent' emissions. Typically, the 100-yr GWP is used.



**6. In a hypothetical scenario based on a global consumption freeze (cap) followed by 4% annual reductions in consumption, the radiative forcing from HFCs reaches a peak near 2040 and begins to decline.** In this scenario, projected total HFC emissions are reduced through 2050 by 70–113 GtCO<sub>2</sub>-eq and HFC radiative forcing by 0.18–0.30 W m<sup>-2</sup> in 2050 (eq. to 4–10 years of CO<sub>2</sub> emissions).



**7. Comparisons of the climate contribution of HFCs in various applications requires a full lifecycle analysis.** Indirect climate forcings associated with HFC or other halocarbon usage are based, for example, on the energy used or saved during the application or product lifetime and energy used to manufacture the product. These and other effects need to be considered in evaluating the total climate forcing impact of HFCs.