THE GNCS FACTSHEETS

Mitigating Hydrofluorocarbons (HFCs)

The regulation of Ozone Depleting Substances (ODS) under the Montreal Protocol is expected to significantly increase emissions of hydrofluorocarbons in the next decades. While HFCs do not deplete the ozone layer, they are a potent greenhouse gas (GHG); molecule for molecule, they are a much more powerful GHG than carbon dioxide (CO_2). Although the radiative impact of HFC emissions is currently tiny (less than 1% of CO_2 emissions), in the absence of actions to reduce them, this share is projected to increase to between 9 and 19% by 2050.[1] Most HFC emissions are tied to the phasing out of ODSs under the Montreal Protocol,[2] and as such were hardly used before 1990.

Uses of HFCs

HFCs are manmade chemicals. They are used in several sectors and emitted during manufacturing (~30% of emissions), product life (~60%) and product disposal (~10%). Employed as refrigerants in the *refrigeration and air-conditioning* sector, they are emitted in the production process, product life, servicing and disposal of this equipment. HFCs have taken a small share of the ODS substitute market for *solvent* applications in such end uses as metal, electronics and precision cleaning. They are also used as blowing agents for *foam manufacture*, and can be released into the atmosphere at any point, from manufacture to disposal or destruction. HFCs are used as propellants in the *aerosol* sector, for such products as metered dose inhalers (MDIs). In the *fire-extinguishing* sector, HFCs are used in portable fire extinguishers and "total flooding systems".[3] Lastly, trifluoromethane (HFC-23), the most powerful greenhouse gas among the HFCs, is emitted as a by-product during the *production of chlorodifluoromethane* (HCFC-22). The latter is used in the refrigeration and air-conditioning sector, as well as for the production of polymers in the foam sector.[4]

Abatement Options

Abatement options for HFCs are as numerous as their applications and, for the most part, sector-specific. While the total phase-out of HFCs by alternatives would be ideal, the conversion to these alternatives is complex, hindered both by the current price of certain abatement technologies and by regulatory frameworks.[5] For instance, alternative propellants for MDIs have failed to meet stringent performance and toxicology requirements.[6] Added abatement potential comes from increasing the efficiency of the relevant industrial processes. For example, in the refrigeration and A/C sector, which accounts for around 70% of HFC emissions, the manufacturing, operation and servicing of units can be improved to minimize leakages; recycling and recovery of refrigerant can lead to more efficient usage. The adoption of different end-of-life disposal practices, namely landfilling and incineration for foams,[7] and the destruction of HFC-23 by thermal oxidation,[8] would also avoid unnecessary emissions.

[1] These projections assume no adoption of a CO_2 stabilization target and are calculated from consumption and emissions data scaled to CO_2-equivalent values, using 100-year Global Warming Potential (GWP). Velders *et al.* (2009). "The Large Contribution of Projected HFC Emissions to Future Climate Forcing." *PNAS*, 106(27).

[2] Molina *et al.* (2009). "Reducing Abrupt Climate Change Risk Using the Montreal Protocol and other Regulatory Actions to Complement Cuts in CO_2 Emissions." *PNAS*, 106(49).

[3] "Total flooding systems" apply an extinguishing agent to an enclosed space to create an atmosphere that is incapable of supporting combustion.

[4] Environmental Protection Agency. (2006). *Global Mitigation of Non-CO_2 Greenhouse Gases*. Washington DC, EPA.

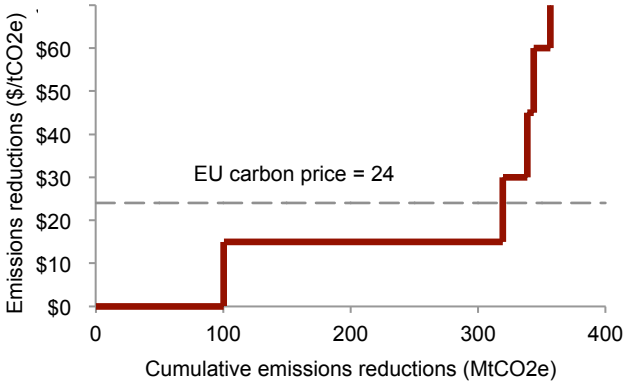
[5] See EPA (2006) for more on potential alternatives to HFCs.

[6] International Pharmaceutical Aerosol Consortium. (1999). *Ensuring Patient Care*. 2nd Edition. Cited in EPA (2006).

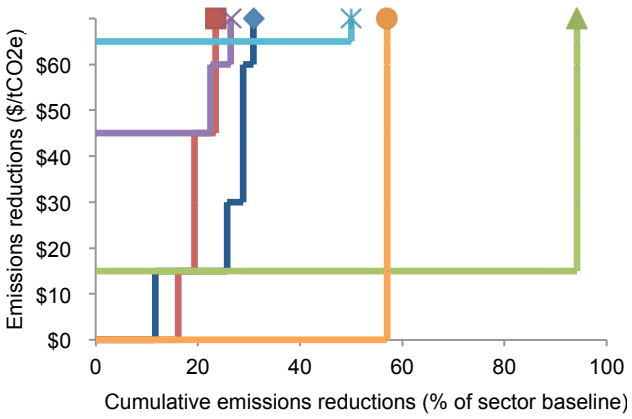
[7] There is concern about the rate of release of blowing agents in landfilling. Incineration has the advantage that the foam does not have to be separated from the blowing agent, which lowers the cost and risk of fugitive emissions (EPA, 2006).

[8] The process of oxidizing HFC-23 to CO_2, hydrogen fluoride (HF) and water.

2020 MAC for HFC emissions, all sectors



2020 MAC for HFC emissions, % of sector



Source: Based on EPA (2006) data

Notes: Legend denotes % sector share of total HFC emissions in 2020. "All sectors" comprise the six listed sectors; notably, this excludes solvents, due to the lack of HFC-specific data. EU price ~$24/tCO$_2$e in April 2011.

Mitigation Potential and Costs

Although HFCs are emitted from a wide array of activities and sectors, the fact that their uses are well defined and often self-contained makes them easier to mitigate than other GHGs. The figures above indicate US Environmental Protection Agency (EPA) estimates of the potential for abatement in million tons of CO_2 equivalent emissions ($MtCO_2e$) and as a percentage of total HFC emissions per sector by 2020. The vertical axes denote the cost per additional ton of abatement – or the marginal abatement cost (MAC) – of CO_2 equivalent emissions. For comparison, the price of permits being traded under the EU Emissions Trading System, as of April 2011, was about $24/$tCO_2e$.

HFCs under the Montreal Protocol

In 2008, parties to the Montreal Protocol and the UN Framework Convention on Climate Change (UNFCCC) acknowledged the importance of considering both ozone and climate consequences in the early phase-out of HCFCs, and discussed how lessons from the Montreal Protocol can be used to address HFC emissions.[9] As pointed out by Molina *et al*. (2009) the Montreal Protocol is an appropriate framework for regulating HFC emissions, as HFCs are, like ODSs, manufactured products, and not by-products of other processes (with the exception of HFC-23). In 2010, the US, Canada and Mexico proposed including the phase-down of HFCs under the Montreal Protocol.[10] This was supported by the majority of parties, but requires consensus to be adopted. A similar proposal was submitted in 2011. According to analysis by the US government, it could achieve emissions reductions of 4,000 $MtCO_2e$ by 2020 and nearly 100,000 $MtCO_2e$ by 2050.[11] In addition, at their 2008 annual meeting, the parties to the Montreal Protocol agreed to begin pilot projects to collect and destroy 'banks' of discarded ODSs to avoid end-of-life emissions. Including HFCs in this goal could avoid further emissions of 5,000 $MtCO_2e$ by 2015.

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Further resources are available at **www.theGNCS.org**

[9] UNEP. (2008). *Report of the Eighth Meeting of the Conference of the Parties to the Vienna Convention and the Twentieth Meeting of the Parties to the Montreal Protocol*. Geneva, UNEP/OzI.Pro. 20/9. [cited in Molina *et al*., 2009].

[10] Phase-down of 85% by 2033 for developed countries and by 2043 for developing countries. See: UNEP Open-Ended Working Group of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer. (2010). *Proposed Amendment to the Montreal Protocol*. UNEP/OzL.Pro.WG.1/30/5. 30 April 2010.

[11] UNEP. (2011). *Proposed Amendment to Control HFCs under the Montreal Protocol (Submitted by Canada, Mexico and the USA)*. May 2011. See: http://ozone.unep.org/highlights.shtml.