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Policies controlling hydrofluorocarbon emissions

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Hydrofluorocarbons (HFCs) are synthetic halocarbons that are used in refrigeration and cooling, aerosols, fire-extinguishing equipment, and solvents. Emissions of these chemicals have risen since the mid-1990s as they increasingly replaced chlorofluorocarbons (CFCs) (Figure 1). HFCs reflect the long-wave radiation emitted from the Earth back to the Earth surface, causing a warming effect. They have a global warming potential (GWP) of up to 40,000 and an atmospheric lifetime of up to 260 years. Efforts are underway in the European Union and beyond to reduce HFC use and emissions as part of climate change mitigation policies.

The identification of the ozone hole in 1974 led to international efforts to restrict the use of ozone-destroying chemicals. These efforts culminated in the signing of the Montreal Protocol on Substances that Deplete the Ozone Layer, which was agreed in 1987 and entered into force in 1989. The Protocol aimed to phase out chlorofluorocarbons (CFCs), halons, and other chlorinated gases with high ozone-depleting potentials (ODPs) by 2000. The Montreal Protocol is thought of as one of the most successful pieces of environmental legislation, having been signed by 197 countries. As a direct result of the Protocol, 97% of ozone depleting substances had been phased out by 2010.

Prior to HFCs, CFCs were used in refrigeration and air conditioning. CFCs have an overall climate cooling effect, because their high ODP of 0.8 to 1.0 (relative to the ODP of CFC11), offsets their high GWP of around 15,000. HFCs replaced CFCs because they have an ODP of less than 0.001; however, this means that the impact of their GWP is significant, resulting in an overall warming effect. Industries favored the replacement of CFCs with HFCs, because they are chemically similar to each other and HFCs could thus be used in existing refrigerant systems. However, concern about the contribution of HFCs to global warming has led to efforts to restrict their use.

Policy controls on HFCs

The MAC Directive – EU (2006) (*1*). This directive aims to ban the use of fluorinated greenhouse gases (including HFCs) in mobile air conditioning (MAC) units in new vehicles by 2017 (Directive 2006/40/EC). However, the directive only includes fluorinated gases (F-gases) that have a GWP higher than 150. It thus allows warming agents up to 150 times more powerful than CO_2 to

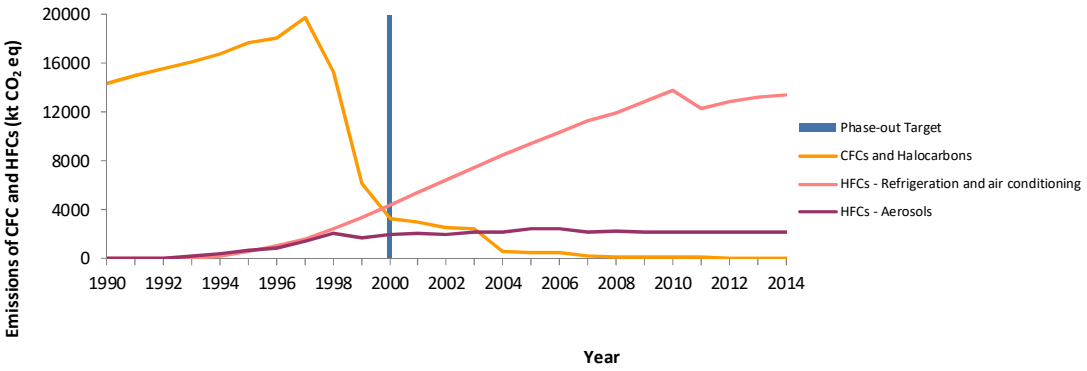

Figure 1. *Decline in CFC emissions after the Montreal Protocol signing in 1987, phase-out target, and rise in HFC emissions. Data from (5).*

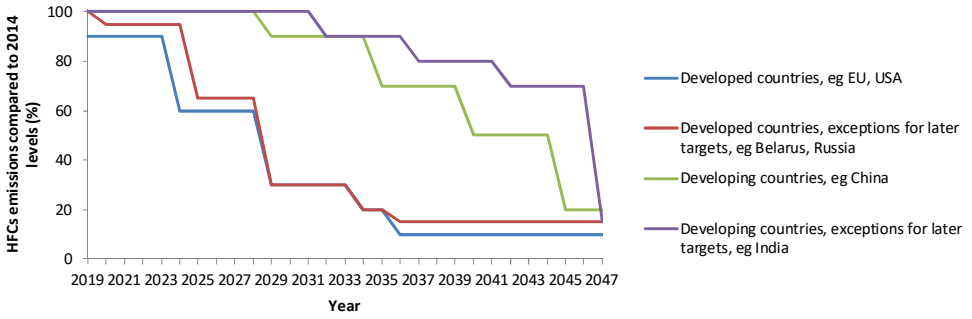

Figure 2. *HFC emission reduction targets, compared to 2014 levels, in the Kigali Amendment, 2016. Data from (3).*

continue to be used. It also fails to account for existing MAC units that use F-gases with a GWP above 150.

Regulations on F-gases – EU (2006, amended 2014) (*2*). Policies were set out to reduce production and consumption of F-gases throughout the EU. The policies aim to reduce emissions from leakages and faulty equipment. The 2014 amendments aim to reduce F-gas emissions to 33% of 2014 emission levels by 2030 (Regulation No. 517/2014).

Kigali Amendment on HFC uses (2016) (*3*). The Kigali Amendment of the Montreal Protocol is a global agreement to limit and reduce HFC emissions. It is estimated that this agreement will prevent emission of ~70 billion tonnes of CO_2-equivalents to the atmosphere by 2050. Under the agreement, developed countries must start to reduce HFC emissions by 2019, with HFC levels of just 10% of current levels by 2036. However, developing countries do not have to start reducing HFCs until 2028, or 2031 for some countries (Figure 2).

Do international policies work?

The success of the Montreal Protocol shows that international policies can work. However, China and India are resisting the rapid implementation of the Kigali amendment. Both countries produce large amounts of HFCs, and their resistance is thus likely to impede the success of phasing out HFCs.

The impacts of HFCs on the climate were identified in the mid-2000s. The delay in politicising these issues internationally, combined with the delayed target reduction schedule, mean that more HFCs will be emitted. This could have serious impacts on keeping global warming below a 2 °C temperature rise, the limit decided on in the 2015 Paris Agreement.

Furthermore, there is a need for suitable alternatives to HFCs. These replacements need to be thoroughly analysed for long-term impacts on the environment to prevent any unintended consequences. Potential alternatives to HFCs for refrigeration include hydrofluoroolefins (HFO), which are unsaturated HFCs with a lower GWP and a short atmospheric lifetime (*4*); hydrocarbons, which have low GWPs of less than 5.5, but raise safety concerns over flammability; and CO_2, with a GWP of 1. However, production of CO_2 refrigerants ultimately comes from fossil fuels.

References

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Georgina Smith wrote this Environmental Brief in partial fulfilment of a module in Environmental Pollution, which contributed to her degree in Environmental Science at the University of Reading. She conducted her BSc dissertation project on terrestrial microplastic distribution and toxicity to Daphnia magna *and was awarded the Franklin Sibly Prize for her performance during her BSc. Upon graduation, Georgina is starting a role as an Environmental Consultant with Golder Associates.*