07 HFCS: REALISING THE POTENTIAL FOR CLIMATE BENEFITS FROM THE MONTREAL PROTOCOL

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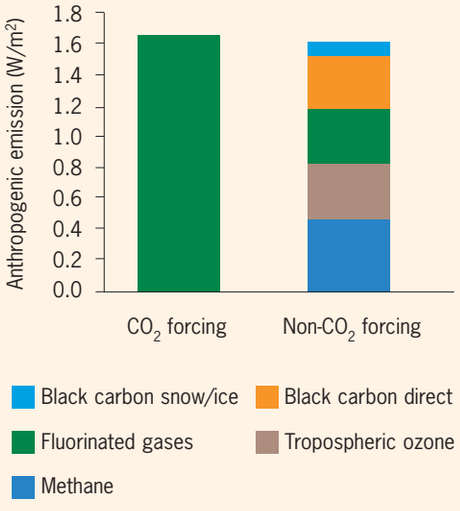
In 1987, the Montreal Protocol phased out the use of chlorofluorocarbons (CFCs), an ozone-depleting substance (ODS) used as coolants in refrigeration and air conditioning. Unfortunately, the chemicals increasingly being deployed in their place, hydrofluorocarbons (HFCs) are themselves exceptionally potent greenhouse gases. They are often called super greenhouse gases because their global warming potential (GWP) is more than carbon dioxide by a factor of 1000.

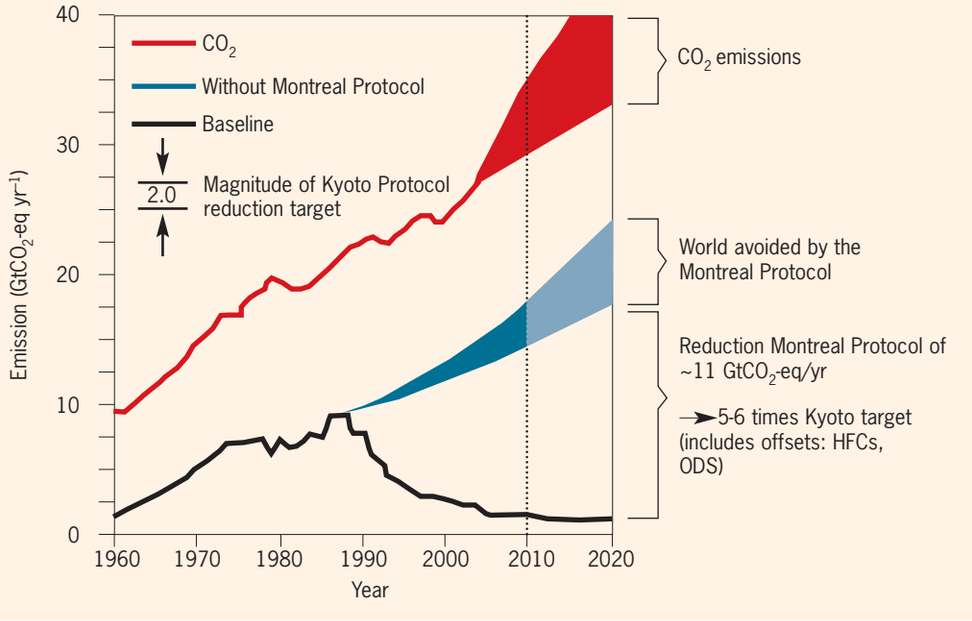
The Montreal Protocol has resulted in a total avoided net annual ODS emissions that are estimated to be equivalent to about 10 billion tons CO_2/ year in 2010 alone, which is about five times the annual reduction target of the Kyoto Protocol for 2008-12. Further, it is considered cost-effective – the Montreal Protocol has not only promoted the recovering of the ozone layer, but has accrued climate benefits of over 100 billion tons CO_2e at a cost of just over $0.02 per tonne CO_2e. Thus the Montreal Protocol has been 10 times more effective

Graph 1: Contribution of CO_2 versus non-CO_2 gases since 1750



Note: Graph does not include all non-CO_2 forcers.
Source: Based on IPCC, WG 1, fig 2.21, AR 4 (2007).

Graph 2: Global warming potential-weighted emissions



Source: Velders et al, PNAS, 2007

HFCs

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than the Kyoto Protocol in delivering climate benefits. A rise in HFCs threatens to unravel all the progress made in tackling global warming.

What are HFCs?

Hydrofluorocarbons (HFCs) are organic compounds that contain only one or a few fluorine atoms. They were introduced into commercial use because they were effective substitutes for ozone-depleting substances (ODSs) such chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). HFCs do not deplete the ozone layer and but like CFCs and HCFCs they are greenhouse gases.

HFCs are the most common group of fluorinated gases (F-gases) which are a family of synthetic gases with a wide range of uses. They are used in various products and applications like

- refrigerants in refrigeration
- air conditioning
- heat pump equipment
- blowing agents for foams
- solvents
- fire extinguishers
- aerosols

HFCs: Rapidly growing threat

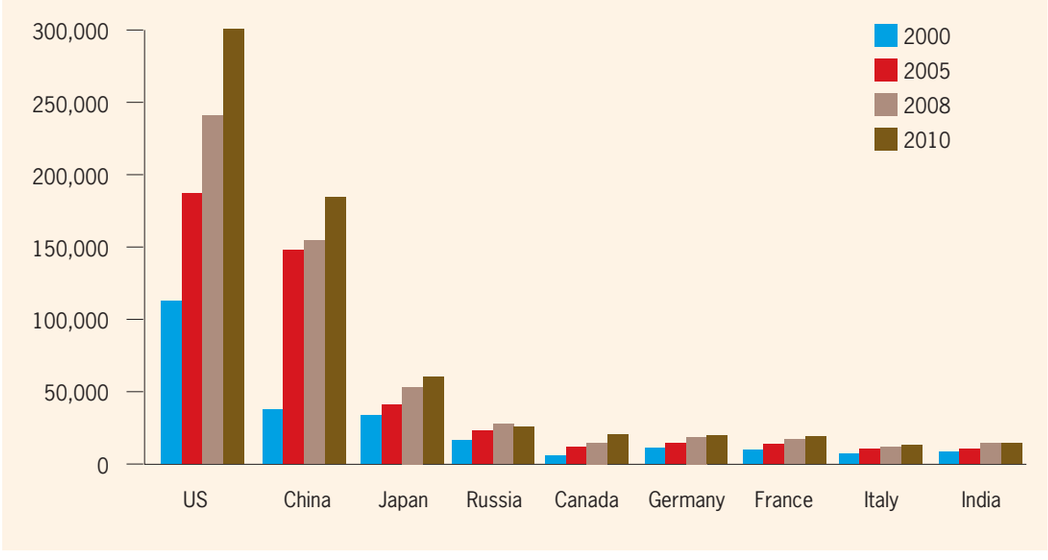
There are several reports that have studied the problem in depth.

- The Technology and Economic Assessment Panel (TEAP) of the Montreal Protocol projects that under a business-as-usual scenario, the emissions of HFCs will increase from 0.21 billion CO_2e in 2002 to about 0.8 billionCO_2e by 2020 – a growth rate of about 8 per cent annually. About 80 per cent HFC emissions in 2020 will happen in the developed countries.
- The US Environmental Protection Agency (EPA) projects that the global HFC emissions will increase by more than four-fold between 2010 and 2030 and reach 1.9 billion tons CO_2e in 2030. In 2030, OECD countries will account for 43 per cent of the global HFC emissions. In SAARC countries, HFC emissions are projected to grow at 17 per cent annually between 2010 and 2030 (largely because of the smaller base) and reach 0.06 billion CO_2e. In 2030, SAARC countries will account for about 3.1 per cent of the global HFC emissions.
- A 2009 study done by the Netherlands Environmental Assessment Agency, the US National Oceanic and Atmospheric Administration, DuPont Fluoroproducts and the US EPA (Velders et al.) is most widely quoted. The study projects HFCs emissions in the range of 5.5-8.8 billion CO_2e per year by 2050. It also projects that the consumption of HFCs in developing countries will become larger than that in developed countries before 2020 and exceeds that in developed countries by up to 800 per cent by 2050. Global HFC emissions in 2050 will be equivalent to 9-19 per cent (CO_2e basis) of projected global CO_2 emissions in business-as-usual scenarios. This percentage increases to 28-45 per cent compared with projected CO_2 emissions in a 450-ppm CO_2 stabilisation scenario.

HFC trends: Consumption and emissions

Global HFC consumption has more than doubled between 2002 and 2010. The CO_2 equivalent

Graph 3: HFC gas emissions (thousand metric tonnes CO_2 equivalent)



Source: The Climate Group

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Leapfrogging HFCs: Unique opportunity

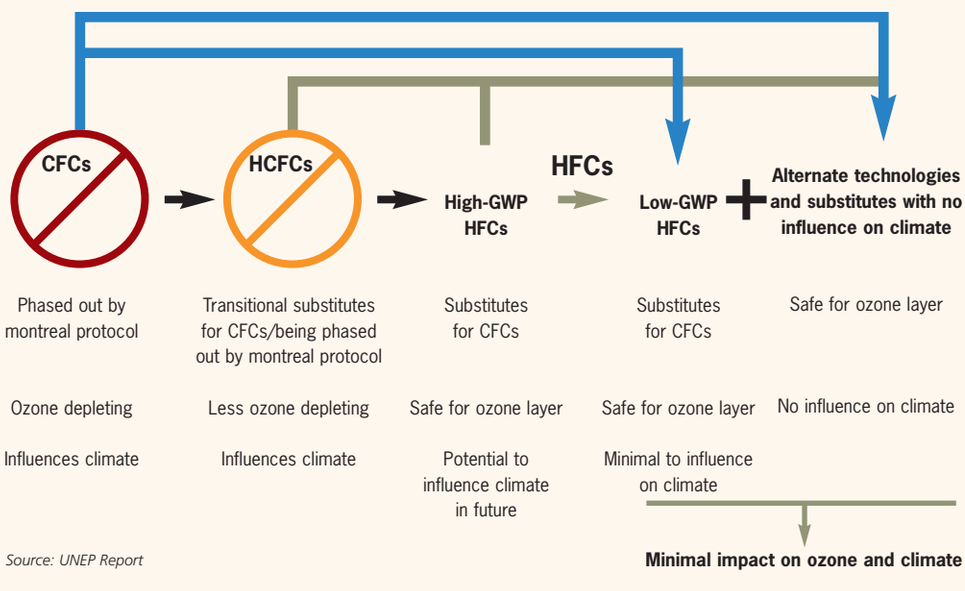
In 1990, countries had the option of moving to a completely different type of gases called hydrocarbons to replace CFCs in the refrigeration and air-conditioning sectors. Hydrocarbons, such as butane and propane, are excellent refrigerants that do not deplete ozone and have very low GWP. But the economic interest of the developed countries and multinational companies triumphed, and instead of non-patented hydrocarbons, patented HCFCs were forced on everyone.

As it was an interim solution, developed countries took a pledge to freeze the production and consumption of HCFCs by 2004 and phase them out by 2020. Developing countries also agreed to freeze HCFCs by 2013 and phase them out by 2030.

But without any effective mechanism, developing countries will transition into HFCs in the next five years as HCFCs are phased out, diverting investment to obsolete HFC technologies and producing significant climate emissions.

Coordinating the phase-down of HFCs with the ongoing HCFC phase-out under the Montreal Protocol will allow Parties to leapfrog high-GWP HFCs entirely and save billions of dollars.

Developing countries would greatly benefit by leapfrogging HFCs altogether, and going straight from HCFCs to long-term solutions that rely on natural refrigerants thus avoiding reliance on more expensive, less energy-efficient HFCs that will need to be phased out. Furthermore, they could finally escape the clutches of the fluorocarbon chemical industry's monopoly over their choice of technology.



Source: UNEP Report

consumption of HFCs increased to more than 1.05 Gt CO_2e in 2010.

In 2010, HFCs emissions accounted for just 1 per cent of the total GHG emissions. However, the emissions have grown at a rapid pace since 2000. Between 2000 and 2010, HFC emissions increased at 9.3 per cent annually. Even in the backdrop of the EU F-gas regulation, a report by the UK-based non-profit Environmental Investigation Agency found that even though the EU has almost completed its HCFC phase-out, its HFC emissions have risen to 28 per cent. This indicated the inefficiency of the regulation to address climate effects of the HCFC phase-out.

Close to 30 per cent of all HFC emissions took place in the US in 2010. In fact, OECD countries accounted for two thirds of all HFCs emissions in 2010. The contribution of SAARC countries to global HFCs emissions was mere 1.6 per cent in 2010.

The major emitting sector is the refrigerators and air-conditioning (R&AC) sector. In 2010, about 80 per cent of the total HFC emissions were from the R&AC sector. The emissions from R&AC sector is projected to increase further and account for about 85 per cent of total HFC emissions in 2030.

The debate

Currently there are two proposals on the table to amend the Montreal Protocol to regulate HFCs. The first by the Federated States of Micronesia (FSM) and Morocco; and the second by the US, Canada and Mexico are being considered at the meeting of Parties to the protocol.

The developed nations believe that the Montreal

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Protocol inadvertently increased HFC use and emissions due to phase out activities of CFCs and hydrochlorofluorocarbons (HCFCs). According to the Vienna Convention for the Protection of Ozone Layer, such a causal nexus triggers an obligation for the Montreal Protocol to act upon reduction of HFCs.

But the developing countries are unwilling to consider new measures without understanding the technological and financial risks. They fear that such phase- down could hamstring their economic growth.

Developing nations are also not convinced about the legality of including non-ozone-depleting substances, such as HFCs, within the Montreal Protocol, given that they were already within the purview of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC).

Developing countries are not confident about the ability of the MLF to pay for the simultaneous phase down and phase out of HCFCs and HFCs as the Multilateral Fund (MLF) is low on funds to even phase out HCFC.

They want more clarity on financial and technological issues before they agree to allow HFCs to be discussed under Montreal.

The solutions

Because HFCs are such powerful GHGs a small amount can seriously damage the climate, but the good news is that eliminating them can also be an effective way of dealing with climate change. Low-GWP alternatives to high-GWP HFCs are widely and increasingly available.

In May 2010, a report from the Technical and Economic Assessment Panel (TEAP) of the Montreal Protocol determined that alternatives are already commercially available or in development. The Montreal Protocol's TEAP uses the term 'low-GWP' to refer to refrigerants with GWPs of 300 or lower while 'moderate-GWP' refers to refrigerants with GWPs of 1,000 or lower. It cautions that differences in energy efficiency could determine which 'low-GWP' or 'moderate-GWP' alternatives would have the lowest overall impact on global warming.

Many of these alternatives have comparable or better energy efficiency than the gases that they are replacing and provide additional climate benefits from reduced energy use and cost savings to consumers.

However, a replacement refrigerant needs to be chosen after a full assessment of the energy-efficiency implications of the alternatives. The Life-Cycle Climate Performance (LCCP) of equipments depends on the direct emissions of the refrigerants and the indirect emissions of greenhouse gases due to the energy use during operations. An alternative that compromises on overall energy efficiency should not be promoted.

The friendly five

Hydrofloroolefins (HFOs)

They are being promoted as the fourth generation of refrigerants, as replacements to HFCs. HFOs are not energy efficient. There are risks related to their toxicity for humans and concerns regarding its LCCP. Additionally, when HFOs break down in the atmosphere they produce trifluoroacetic acid (TFA), which is also toxic for the environment.

Hydrocarbons

Hydrocarbon (isobutane R600a) and propane (R290) are not ozone-depleting. They have a global warming potential of below 20, are non-toxic, less expensive than synthetic refrigerants and accomplish many of the specifications required for refrigerants, foam-blowing agents and aerosol propellants.

However, they are flammable and this has been the most significant barrier against their widespread application. But they are used in over 300 million household fridges across Europe, Japan, Russia and China. The properties of certain hydrocarbons make them stand out as very efficient refrigerants. They are used in domestic refrigeration, small commercial cooling air-conditioners, foams and insulation.

Ammonia

Ammonia has the lowest GWP (0) of all refrigerants suitable for large refrigeration systems. Ammonia refrigeration-systems also usually achieve higher energy efficiency than HFC refrigeration-systems. Although ammonia is toxic, it has a pungent odour and thus a high warning effect. It has been the standard refrigerant for industrial refrigeration systems for more than 125 years. Ammonia refrigeration systems cost 10-20 per cent less to install than the competitive industrial refrigerants.

CO_2

In spite of its notoriety as a greenhouse gas, CO_2 has very positive characteristics as a refrigerant. It does not deplete the ozone layer and its GWP is 1 (compared to thousands for a typical HFC). It is cheap and safe. Its properties permit the design of smaller components and more compact systems with its main uses being in vehicle air-conditioning and supermarket refrigeration.

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Low GWP HFCs

HFC-152a, a colourless, flammable gas, is used as a non-ozone-depleting aerosol propellant. Its global warming potential is 140 compared to carbon dioxide for an integration time horizon of 100 years. In experimental animals HFC-152a possesses a low order of acute inhalation toxicity, although it can induce cardiac sensitisation at high exposure. Japanese companies are pushing for HFC-32, a medium-GWPHFC, as the most energy-efficient substitute for HCFC.

Energy efficiency

The Global Warming Potential of hydrofluorocarbons (HFCs) led the negotiators to focus almost entirely on reducing their emissions and deriving climate benefits, which has shifted the debate away from their effects on energy use and improvements of energy efficiency from equipment.

The impact of refrigeration and air-conditioning systems on global warming is through both energy use and refrigerant emissions. Poorly designed, badly maintained refrigeration units abandoned at the end of their life without recovering or recycling can lead to emissions into the atmosphere. These emissions are known as the 'direct' emissions. The direct impact is relatively small.

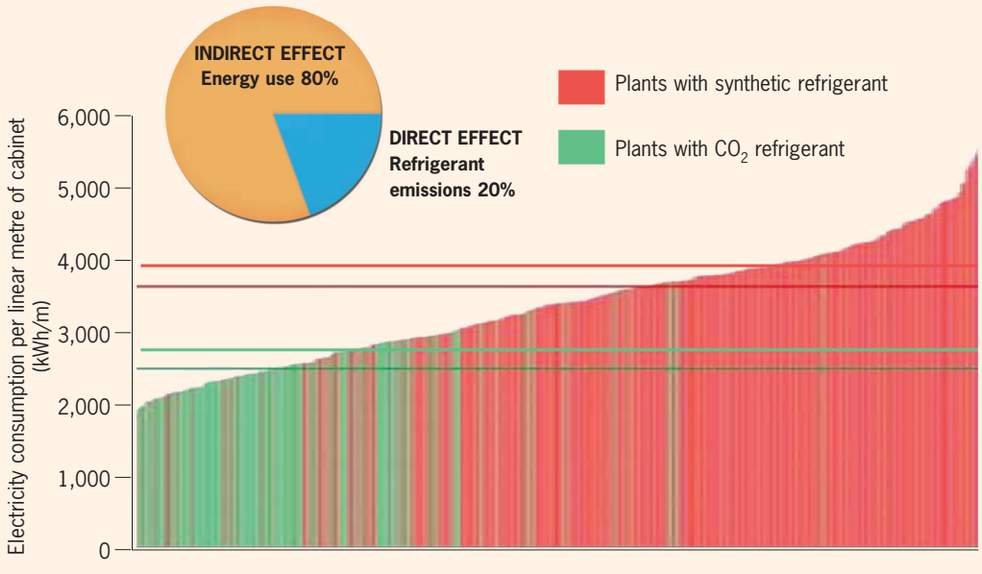
Refrigeration equipment consumes electricity, produced in general by burning fossil fuel that emits CO_2 into the atmosphere. This 'indirect' effect can represent more than 80 per cent of its impact. The reduction of indirect impact of refrigeration and air-conditioning units lies essentially in the improvement of their energy use.

Adopting cooling technology that is both cost-effective and energy-efficient could save over 192 terawatt-hours per year by 2020, the same amount of energy as produced by 64 medium-sized power plants.

Energy efficiency examples:

- Japanese retail giant AEON reports energy savings of between 10 and 30 per cent and an overall CO_2 reduction of 50 per cent in the stores where it switched to using natural refrigerants since 2009.
- French retailer Carrefour's store in Istanbul, Turkey, which uses natural refrigeration, reports an energy efficiency improvement of around 15 per cent.
- Tesco has begun using natural refrigerant systems in one of its Thai stores, resulting in a 5 per cent energy saving.
- All newly built and refurbished Coop Schweiz stores in Switzerland use natural refrigerant systems for cooling and a quarter of its stores are already running on this technology, reducing their energy needs by about 30 per cent.
- In Hungary, Auchan has also achieved an energy saving of 35 per cent with its natural refrigerant systems.
- H-E-B in the southern United States expects to achieve a 50 per cent energy reduction in its new store in Austin, Texas, which uses natural refrigeration only.

Graph 4: Energy efficiency of HFC refrigerants versus CO_2



Source: Courtesy of Coop Schwetz

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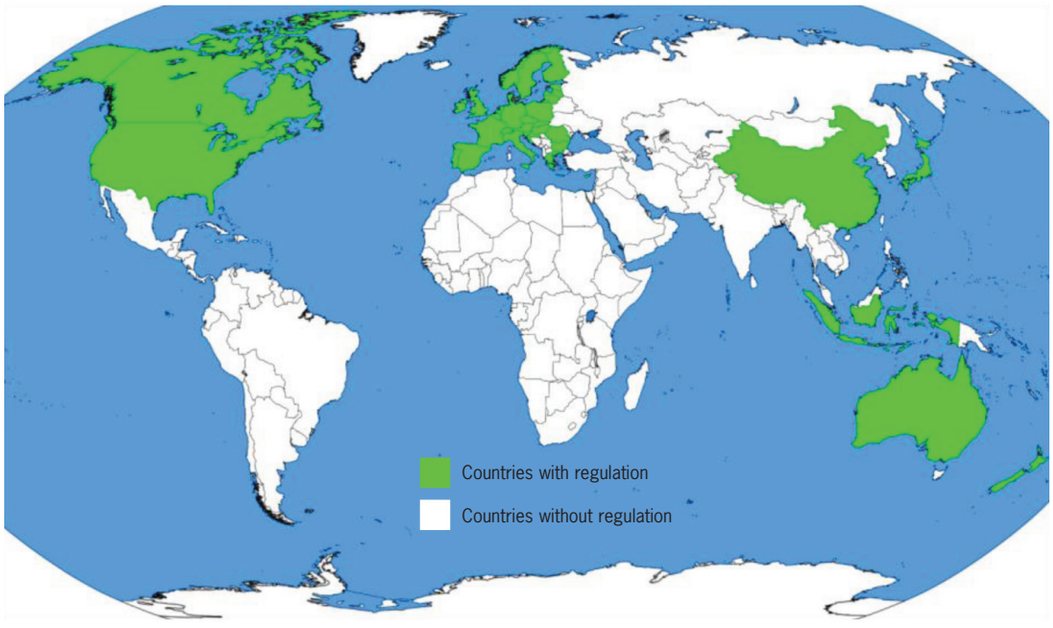
Countries with HFC regulations



Source: IGSD's Primer on Short-Lived Climate Pollutants, 2014

Who will pay for the transition?

The Multilateral Fund was set up under the Montreal Protocol to assist developing countries in defraying the 'incremental costs' incurred as a result of the phase-down on ODS under the Protocol. The developed countries agreed to contribute to the Fund in order to help countries achieve the Protocol's goals. The Fund has financed projects ranging from the development of individual country ODS-elimination programmes to the building of large-scale industrial facilities that use alternate technologies.

Under the MLF, countries can receive up to a 25 per cent premium in funding if they transition to environmentally friendly alternatives rather than HFCs.

Policy options to regulate and potentially mitigate HFC:

- Regulations, like binding technological or performance standards or product bans
- Financial incentives to reduce emissions, production, import or consumption or incentivise collection, destruction or substitutes
- Voluntary agreements with industry and non binding best practice standards

Conclusion

The Montreal Protocol has universal membership and provides robust implementation of the principle of 'common but differentiated responsibilities'. This means that developed countries adopt control measures first, followed by typical grace periods of 10 to 19 years before developing countries are subject to control measures, with funding for the agreed incremental cost of the developing country phase-out provided by the developed countries through the MLF. Additionally, the Protocol and the convention have provided for a body to assess the scientific issues arising out of the Protocol and its parent convention. The combination of these features has allowed all Parties to comply with the control measures; to date, the Parties have phased out 97 per cent of nearly 100 damaging chemicals.

A 2013 report states that HFC phase-down and a direct transition to natural refrigerants can help eliminate 5-8 billion tonnes of CO_2e. It is simple mathematics. We can only emit 990 billion tonnes of mitigate CO_2 between 2012 and 2100 if we want to keep the rise of global temperature less than 2 degrees Celsius.

There is indeed growing recognition that HFCs can be most effectively regulated through the phase-down of their production and consumption under the Montreal Protocol as a complement to their emission control under the Kyoto Protocol. The Montreal Protocol has the experience and expertise to ensure a rapid and effective phase-down of HFCs, which are in the same family of gases, have similar chemical properties, and are used in the same sectors as the CFCs already phased out and the HCFCs currently being phased out. Because all CFCs and HCFCs are also greenhouse gases, between 1990 and 2010 the Montreal Protocol reduced CO_2eq emissions many times more than the reduction goal of the first commitment period of the Kyoto Protocol.

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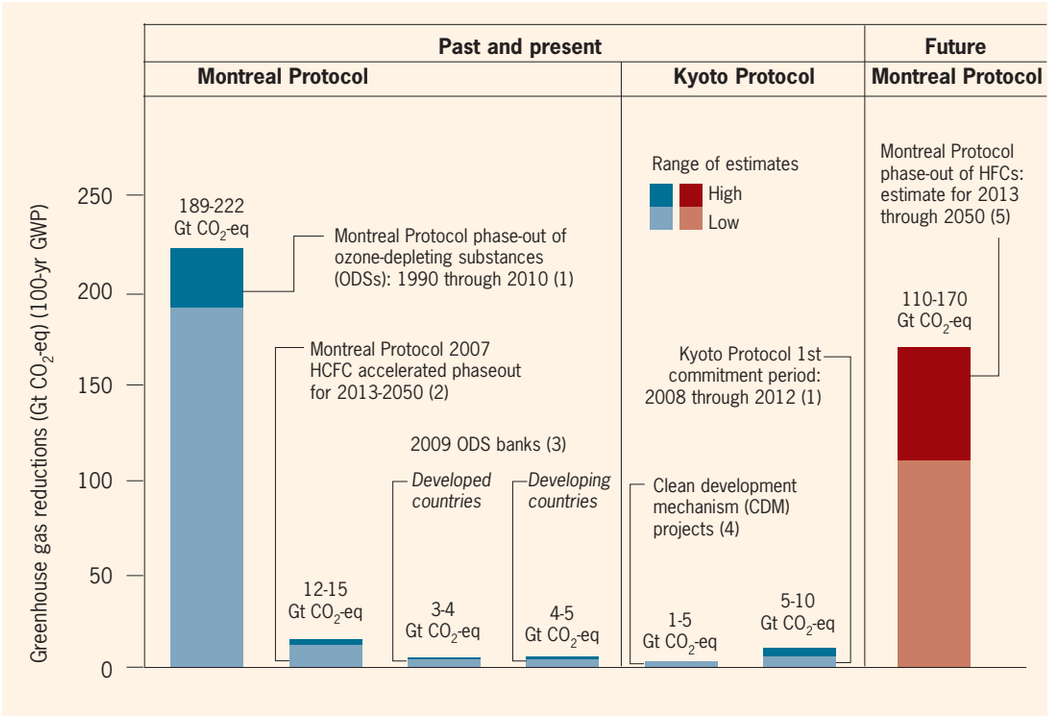
Graph 5: Climate benefits from the Montreal Protocol versus Kyoto Protocol



Source: Prepared for IGSD by David Fahey (NOAA)

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