FACING THE F-GAS CHALLENGE

THE NEED FOR A GLOBAL PHASE-OUT OF HFCS

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SUMMARY

In September 2007, the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer agreed to accelerate the phase-out of HCFCs, a group of ozone-depleting substances that were initially promoted as substitute chemicals for CFCs. The resulting decision has the potential to prevent emissions of HCFCs equivalent to 25 billion tonnes of carbon dioxide (CO_2).[1]

The agreement in Montreal presents a unique chance to control the impact of man-made fluorinated gases, known as F-gases, on the climate. The direction of the refrigeration sector over the next 30 years will be determined by which signals are sent now to the international market. This creates an enormous opportunity - but also a risk that substitute technologies will focus on hydrofluorocarbons (HFCs) which, while not damaging to the ozone layer, could have an equally negative impact on climate change.

Production and use of F-gases, including HCFCs and HFCs with high Global Warming Potentials (GWPs), is growing rapidly. Unlike CO_2 and other greenhouse gases under the purview of the Kyoto Protocol, these gases are deliberately produced for industrial purposes, even though climate and ozone-neutral alternatives exist.

If a strong signal is sent by the international community that HFCs will be actively addressed, the potential sea-change in technology over the next decade could prevent hundreds of billions of tonnes of CO_2 equivalent (CO_2-eq.) emissions over the next 50 years.[2] If HFCs are not controlled, production will continue to expand and the climate benefit of the Montreal Protocol decision to phase-out HCFCs will not be realised.

EIA is therefore calling for rapid agreement by the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) to phase-out production and consumption of HFCs, through the establishment of a framework agreement with lessons learned from the successful CFC phase-out under the Montreal Protocol.

ACKNOWLEDGEMENTS

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DECEMBER, 2007

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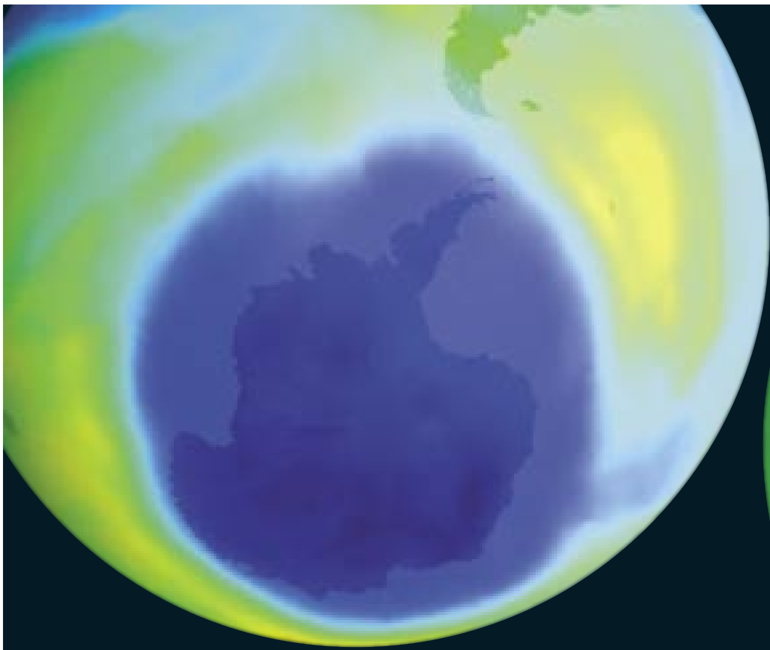

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BACKGROUND:
TRAPPED BETWEEN CONVENTIONS

F-gases are man-made fluorinated gases. They include CFCs, HCFCs, HFCs, PFCs and sulphur hexafluoride.[3] Regulatory control over these substances is split between the Montreal and Kyoto Protocols. The Montreal Protocol has control over the ozone depleting CFCs and HCFCs, whereas non-ozone depleting HFCs and PFCs are within the purview of the Kyoto Protocol.

The United Nations Framework Convention on Climate Change (UNFCCC) works towards the stabilisation of greenhouse gas (GHG) emissions. The Kyoto Protocol is an amendment to the UNFCCC that requires developed countries to reduce their emissions of CO_2 and five other GHGs (methane, nitrous oxide, sulfur hexafluoride, HFCs and PFCs). Although HFCs and PFCs are replacements for some ozone depleting substances (ODS), they are regulated under the Kyoto Protocol (and not the Montreal Protocol) because they are not themselves ODS. However, given the overlap both in the causes and effects of ozone depletion and climate change, and in policy responses, it has become increasingly obvious that coordination between the two treaties is imperative.

HFCs are the most significant group of F-gases under the control of the Kyoto Protocol. In glaring contradiction to the goals of the UNFCCC, concentrations of HFCs in the atmosphere are rising rapidly. Between 2001 and 2003, HFC atmospheric concentrations rose at a rate of 13-17% per year.[4] A 2005 IPCC (Intergovernmental Panel on Climate Change) report predicted a tripling of annual HFC emissions from 0.4 billion tonnes CO_2-eq. in 2002 to 1.2 billion tonnes CO_2-eq. in 2015, unless mitigation measures are taken.[5] The IPCC Fourth Assessment Report released in November this year further warns that emissions from HFCs are expected to grow substantially in the future.[6]

The good news is that there is a simple and cost effective solution to the HFC problem. HFC uses are more easily defined and addressed than energy consumption, and are highly suitable for a multilateral phase-out agreement, as demonstrated by the successful phase out of CFCs (and currently HCFCs) under the Montreal Protocol. With a variety of climate neutral alternatives already in use, the timing is right for a global agreement to phase out HFCs.

The Montreal Protocol presents invaluable lessons in how such a phase out could be achieved. Widely considered the most successful international environmental agreement to date, the Montreal Protocol has done much to protect both the ozone layer and the global climate. Having phased out more than 95% of ozone depleting chemicals, many of which are also powerful greenhouse gases, the Montreal Protocol will have reduced emissions of greenhouse gases by an estimated 135 billion tonnes CO_2-eq. from 1990 to 2010.[7]

THE MONTREAL PROTOCOL 20TH ANNIVERSARY AGREEMENT

The 19th Meeting of the Parties to the Montreal Protocol agreed to an accelerated phase out of HCFCs in developed and developing countries. Developed countries, having already frozen production, are required to phase out production and consumption in steps, with full phase-out by 2020. Developing countries are required to freeze production in 2013, at average the level of 2009-2010, and undertake a graduated step-down in consumption and production to a full phase-out in 2030. Experts calculate that this accelerated phase out has the potential to reduce emissions by as much as 25 billion tonnes CO_2-eq. by 2050, provided that additional measures are taken to replace HCFCs with substitutes and alternatives that have zero or low Global Warming Potentials (GWPs) and to improve the energy efficiency of refrigeration and air conditioning equipment.[8]

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THE LANDSCAPE

Hydrofluorocarbons (HFCs) were introduced in the 1990s as transitional chemicals to aid the phase out of CFCs. Unlike CFCs, HFCs do not deplete the ozone layer, however they do have high GWPs, ranging from 53 to almost 15,000 times that of CO_2 over a 100 year time frame (see Figures 2 & 3). Rather than acting as temporary replacements that would allow time for the development of more climate neutral alternatives, HFCs have become entrenched in the refrigeration industry and have stifled the growth of alternative technologies.

HFC-134a currently dominates the HFC market, accounting for almost two-thirds of all HFCs in use.[9] Introduced in the early 1990s, it is now used widely throughout the refrigeration and foam industries. Production capacity of HFC-134a has risen steeply from very low levels in 1990 to 185,000 tonnes in 2002.[10] This has had a significant effect on atmospheric concentrations of HFC-134a which have been rising at an average rate of 20% per year since 2000.[11] The production of other HFCs, mostly blends, is also growing rapidly.[12]

HFC PRODUCTION BY SECTOR

Mobile air conditioning (MAC) industry

In 1990 the mobile air conditioning (MAC) sector was responsible for 60% of CFC-12 consumption.[14] After the CFC phase-out was agreed, the car industry looked to HFC-134a as a substitute, and by the mid-nineties, CFC-12 had been replaced by HFC-134a in almost all countries.[15] Although HFC-134a is used in many other applications today, the automotive industry is still an important source of demand. As Figure 1 shows, MAC emissions dominate other sectors, accounting for over 65% of all HFC refrigerant emissions.[16]

Commercial refrigeration

The commercial refrigeration sector is the second biggest contributor to HFC refrigerant emissions. This is primarily a result of high leakage rates from installed equipment, estimated at up to 30% annually.[17] This is made more problematic by the high GWP HFC blends which are frequently used in the sector; for example key blends used include R-404a, with a 100 year GWP of 4540 (see Figure 3).

Closed cell foams

The production of closed cell foams requires the use of HFCs as blowing agents for making expanded plastics (such as the expanded polystyrene used in packaging materials). HFC-134a is predominantly used in this sector. Other HFCs used include HFC-227ea, HFC-245fa and HFC-356mfc. Emission rates are estimated to be three percent annually with a 32.5% loss in the first year.[18] The insulating foam sector is expected to become one of the largest HFC growth areas and is predicted to become the second largest source of HFC emissions.[19] By 2015 experts estimate that HFC emissions from closed cell foams will reach 20 million tonnes CO_2-eq. per year.[20]

Stationary air conditioning

HCFC-22 has been the key refrigerant used in stationary air conditioning, servicing as much as 90% of all installed systems.[21] With the phase-out of HCFCs, HFC blends have been developed as substitutes for HCFC-22. The most popular HFC blend in this sector within the US is R-410a.[22] In Europe HCFC-22 has been replaced with R-407a (an HFC blend) and hydrocarbon HC-290 (propane).

Domestic refrigeration

Worldwide more than 80 million fridges and freezers are produced each year.[23] Since the phase-out of CFC-12, the alternatives HFC-134a and HC-600 (isobutane) have become the dominant refrigerants in the market.

THE CHALLENGE

HFCs : the new HCFCs?

In 2005 global production of HCFCs was estimated at 280,000 metric tonnes, with developing country production rising dramatically.[25] According to World Bank data, consumption of HCFCs in developing countries alone is expected to exceed half a million metric tonnes by the time the phase out baseline years are set (2009-2010).[26] Consumption and production of HCFCs is due to be phased out by 2030, with a 2.5% servicing allowance allowed in developing countries for another ten years.

Producers of HFCs have invested heavily in the creation and patenting of new HFC blends designed to directly replace HCFCs. HCFC-22 is used prolifically throughout the refrigeration industry, occupying about 65% of global consumption of HCFCs.[27] According to the industry, HFC blends such as R-410a are predicted to become one of the most important substitutes for HCFC-22.[28] In 2006 Arkema, one of the world's largest fluorochemical producers, invested $45 million in its American production plant for HFC-32 (one of the components of R-410a) in order to help supply the North American market.[29]

Expanding east

By 2015 China is predicted to be the most important refrigerant market in the world.[30] Statistics show a recent shift in the location of HCFC production towards developing countries which have rapidly growing economies and increased demand for refrigeration and air conditioning systems.

At present the HFC market in developing countries is small. However, without financial assistance supported by international regulations to assist the transition to climate neutral alternatives, it is likely that HFCs will expand into these new markets. HFC producers are keen to capitalise on this potential growth area and have expressed their intention to expand into Asia, where patent protection has not yet been established.[31] Earlier this year Honeywell announced an agreement with a leading home appliance manufacturer based in Guangdong Province, China, to supply HFC blowing agent to insulate refrigerators.[32] Similarly, in 2003, DuPont responded to strong growth in HFC-based air conditioning and refrigeration equipment in Asia by announcing a joint venture with a Chinese company to expand production of HFC blends.[33] HFC giant Arkema recently revealed plans to expand the share of its overall sales in Asia from 13% in 2007 to 20% by 2012.[34]

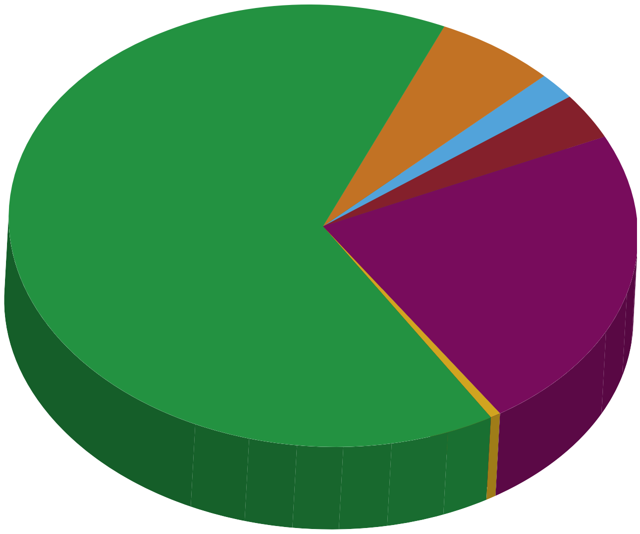

FIGURE 1 HFC refrigerant emissions by sector.[24]

INDUSTRIAL DESIGNATION OR COMMON NAME	GLOBAL WARMING POTENTIAL FOR GIVEN TIME HORIZON		LIFETIME (YEARS)
	20 YEARS	100 YEARS	
CHLOROFLUOROCARBONS			
CFC-11	6,730	4,750	45
CFC-12	10,990	10,890	100
HYDROCHLOROFLUOROCARBONS			
HCFC-22	5,160	1,810	12
HCFC-141b	2,250	725	9.3
HYDROFLUOROCARBONS			
HFC-23	11,990	14,760	270
HFC-32	2,330	675	5
HFC-125	6,340	3,500	29
HFC-134	3,400	1,100	9.6
HFC-134a	3,830	1,430	14
HFC-143	1,240	353	3.5
HFC-143a	5,890	4,470	52
HFC-152	187	53	0.6
HFC-152a	437	124	1.4
HFC-227ea	5,310	3,220	34.2
HFC-236fa	8,100	9,810	240
HFC-245ca	2,340	693	6.2
HFC-245fa	3,380	1,030	7.6
HFC-365mfc	2,520	794	8.6

FIGURE 2 GWP and Atmospheric lifetimes of halocarbons [62]

INDUSTRIAL DESIGNATION OR COMMON NAME	100 YEAR GWP	HFC COMPONENTS
R-404A	4540	R-125/143a/134a (44/52/4)
R-407C	1525	R-32/125/134a (23/25/52)
R-410A	2340	R-32/125a (50/50)
R-507	4600	R-125/143a (50/50)

FIGURE 3 GWP and HFC components of HFC blends [62]

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CLIMATE NEUTRAL SOLUTIONS

Mobile air conditioning

The MAC sector represents over 50% of global demand for HFCs.[35] In July 2006, the European Union's F-gas regulation banned the use of MAC refrigerants with a GWP over 150 in new model cars by 2011 and in all cars by 2017. Within weeks, major chemical manufacturers announced they had developed low GWP substitutes for HFC-134a.[36] A German automotive industry expert has claimed that CO_2 has equal performance to HFC-134a and is rapidly emerging as a strong contender to replace HFC-134a.[37] Within the Australian market, hydrocarbon blends have been introduced to replace both CFC-12 and HFC-134a.

Commercial sector

The commercial sector is the second largest source of global demand for HFCs. In response to the environmental problems associated with the use of HFCs, several large multinational companies such as Coca-Cola, Unilever and Schweppes have made pledges to phase out HFC use. These companies have partnered with the United Nations Environment Programme (UNEP) and Greenpeace in order to collaborate on initiatives and encourage other companies to eliminate GHGs from refrigeration equipment. In 2007, PepsiCo, IKEA and Carlsberg joined the alliance.[38]

The use of ammonia (NH_3) as a refrigerant in the commercial sector is well established. It has been used to replace HCFC-22 in applications such as water chillers and commercial refrigeration systems for supermarkets throughout Germany.[39] Unilever, the world's largest ice cream business, uses ammonia for all industrial-scale refrigeration requirements within Europe.[40]

Hydrocarbon refrigerants are also gaining popularity. In additional to negligible GWPs, long-term trials in Australia have showed a nine percent reduction in energy use compared with HFC cabinets.[41] As of April 2007, around 200,000 hydrocarbon cabinets have been installed by Unilever throughout Europe.

CO_2 is also a viable alternative to HFCs in the commercial refrigeration sector. CO_2 cascade systems in supermarkets are now widespread within Europe. Coca-Cola has recently pledged that all of its coolers and vending machines will feature HFC-free insulation and CO_2 natural refrigerant at the 2008 Olympics in Beijing. Coca-Cola believes that, over their ten-year life span, these 6,350 climate-friendly refrigeration units will reduce GHG emissions by 45,000 metric tonnes.[42]

Foam blowing agents

Hydrocarbons were originally used as substitutes for CFC-11 blowing agents in the production of insulating foams. They have since been used as replacements to HCFC-141b in the foam blowing sector for several years and are officially recognised by the US Environmental Protection Agency (EPA) as viable alternatives to HCFCs in various foams used in the construction industry.[43] In 2005 hydrocarbons were expected to represent over 55% of global blowing-agent usage.[44]

Stationary Air conditioning

Some hydrocarbons have been used as substitutes for HCFC-22 in the stationary air conditioning sector, mostly in systems with indirect cooling.[45] For example, in 2003 around 90,000 portable air conditioners using HC-290 (propane) were sold around the world.[46]

Domestic Refrigeration

HC-600 (isobutane) is widely used in domestic refrigerators and commercial units. Mass production of domestic refrigeration appliances containing HC-600 began in the early 1990s and has spread globally, except in the USA due to regulations preventing their use. Today over 120 million domestic refrigeration units containing hydrocarbons have been produced worldwide.[47]

Lessons from Europe

In 2007, Europe brought into force the F-gas regulation. The most significant aspect of the regulation is within the MAC sector. The legislation was introduced in order to spur technological innovation in the development of alternative, environmentally neutral technologies, and it has been successful in instigating the viability of the CO_2 MAC alternative system.[48]

Although the F-gas regulation promotes technology innovation in the MAC sector, in other sectors it relies primarily on containment and recovery of HFCs by operators. The regulation does not address the rising consumption of HFCs in other sectors and the overall success of containment and recovery of HFCs has already been brought into question. A modelling analysis of data produced by the fluorocarbon industry found that production figures for HFC-134a fitted a non-containment market model much closer than a containment market model. The analysis concluded that containment in refrigeration and air-conditioning sectors had failed.[49]

Doubts over the recovery of HFCs in existing developed country markets should flag even greater concern in developing countries, where regular preventive maintenance of air-conditioning and refrigeration equipment is rare.[50]

Existing mechanisms for the recovery of F-gases such as HCFCs and CFCs are few. In 2002 refrigerant recovery was estimated at 32,500 metric tonnes, less than 5% of the annual refrigerant market.[51] In developing countries there is currently no effective recovery of refrigerants.[52]

A positive aspect of the EU's F-gas regulation is that it allows member states to maintain their own stricter regulations should they wish. Several states have gone much further than the F-gas regulation in dealing with HFC consumption. Nordic nations such as Denmark and Sweden operate tax and refund schemes, whereby imports of HFCs are taxed per tonne of CO_2-eq. The equivalent amount is refunded for (used) gas that is delivered for destruction. Market data indicate that these schemes have led to increased awareness of climate neutral alternatives.[53] In addition to the tax/refund scheme, Denmark has banned the use of new equipment containing or using F-gases, with some exemptions.

In 2003 Austria implemented the Ordinance for Industrial Gases, eliminating the use of HFCs in stages so that by 31 December 2007, the domestic use of HFCs and PFCs as refrigeration and cooling agents and in foams will be banned. The legislation allows some exceptions, for example HFCs with a GWP value of less than 300 may continue to be used in some foams.[54]

HFC-23 AND THE CLEAN DEVELOPMENT MECHANISM (CDM)

HFC-23, an unwanted by-product of HCFC-22 production, is one of the most abundant HFCs in the atmosphere and its concentration there is rising steadily. The CDM allows eligible HCFC-22 facilities that capture and destroy their by-product emissions of HFC-23 to earn Certified Emissions Reductions (CERs) or carbon credits, which can be sold at a significant profit on the global carbon market. Under the current CDM methodology only plants with an operating history of at least three years between January 2000 and end of December 2004 can be eligible for credits.[55] This leaves open the question of how to deal with 'new' HCFC-22 production facilities.

While HFC-23 destruction projects have eliminated a portion of emissions of HFC-23, which has a GWP of 14,760, they have also created a 'perverse incentive' by inadvertently subsidizing production of HCFC-22 and thereby encouraging its expanded use.[56] The CDM credits earn up to ten times the cost of capturing and destroying HFC-23 emissions and are exceeding the sales revenue of HCFC-22.[57] As a result CERS issued from HFC-23 destruction have dominated the CDM, accounting for 52% of all project-based volumes in 2006 (down from 64% in 2005).[58] To date 41.6 million CERs have been issued from HFC-23 destruction projects.[59] At current CER prices this is worth over $1 billion.[60]


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The issue of incorporating new HCFC facilities into the CDM is problematic due to this perverse incentive encountered, however it is essential that new facilities are given some kind of incentive to abate their HFC-23 by-product. In 2005 the IPCC estimated that, without abatement, HFC-23 emissions could rise by 60% to 23,000 tonnes per year by 2015, equivalent to 269 million tonnes CO_2–eq. annually.[61] Although the recently agreed HCFC phase-out will effectively reduce overall HFC-23 production, it is clear that significant quantities will continue to be produced over the next twenty years.

The complexity and unintended consequences of HFC-23 destruction projects under the CDM further underscore the benefits of a coherent approach to an HFC phase-out. The necessary measures to ensure the elimination of all HFC-23 emissions can be best developed as part of an international phase out plan for all HFCs. In the near term, EIA urges nations which have already received large revenues from the CDM to contribute a proportion to cover the costs of future HFC-23 destruction. Those that do not have such funds available should receive the assistance to cover the cost of HFC-23 destruction, preferably outside of the CDM.

CONCLUSIONS

It is widely acknowledged that HFCs are not a solution to the phase-out of CFCs and HCFCs. Their high GWPs signal that, sooner or later, their use will not be acceptable on any industrial scale. A decisive move to prevent the proliferation of these environmentally damaging chemicals at the Bali climate conference will yield enormous climate benefits, especially in light of the recent decision taken by the Montreal Protocol to accelerate the phase out of HCFCs.

As the path for a post 2012 agreement is forged, lessons can be learned from other environmental treaties. The Montreal Protocol's Multilateral Fund has successfully ensured the phase-out of more than 95% of ozone-depleting substances. EIA urges parties to the UNFCCC and the Kyoto Protocol to develop an effective financial mechanism that can assist developing countries in the transition away from HFCs to climate neutral alternatives.

RECOMMENDATIONS

Parties to the UNFCCC and the Kyoto Protocol should fast track discussions to develop a global framework agreement to phase-out HFCs. This agreement should include the development of a fund to oversee and finance the transition from HFC technologies to climate neutral alternatives and a mechanism to deal with HFC-23 byproduct destruction that does not create perverse incentives through the CDM.

Governments concerned with climate change should voluntarily implement HFC phase-out policies that promote the introduction of climate- and ozone-neutral alternatives and commit to achieving 100% HFC-23 destruction as a matter of national policy.

DECEMBER, 2007

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