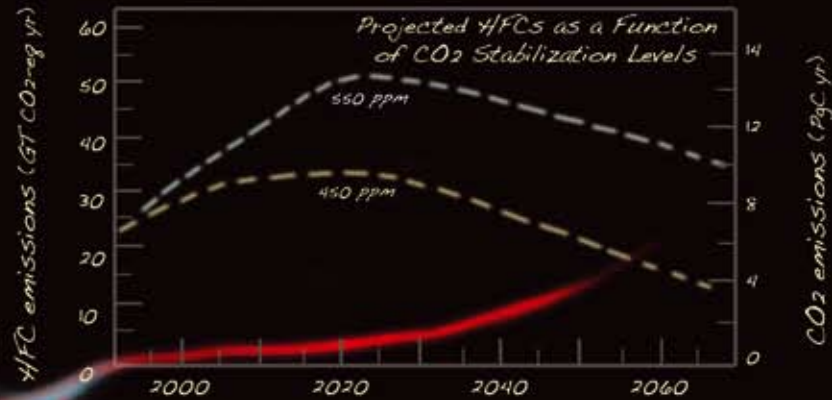


# The HFC imperative

## Essential action for global climate protection



# Left unchecked HFC use will prove fatal to efforts to arrest and reverse climate change

## ACKNOWLEDGEMENTS

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## Executive summary

The Montreal Protocol has been extremely successful in enabling the phase-out of ozone depleting substances (ODS). As a result of these phase-outs, hydrofluorocarbons (HFCs) have been commercialized as substitutes for ODS. The HFCs being used as ODS substitutes are powerful greenhouse gases (GHG) with global-warming potentials (GWP) hundreds to thousands of times greater than carbon dioxide (CO<sub>2</sub>). Recent scientific evidence indicates that GWP-weighted HFC emissions alone could equate to as much as 45% of CO<sub>2</sub> emissions by 2050, thus eclipsing efforts to redress global warming.

The disproportionate impacts of HFCs on global warming distinguish HFCs from other greenhouse gases. As 'super-GHGs' undergoing explosive growth in production and use, action to limit HFC use is critical to the success or failure of efforts to combat global warming. It is essential that any realistic prospect for successful climate mitigation include early and accelerated schedules for HFC retirement. Failure to do so will effectively cancel out and render useless all other attempts to combat global warming.

The Montreal Protocol has more than twenty years experience of working with the industrial sectors that are now shifting to the use of HFCs and is uniquely suited to take on the immediate phase-out of high-GWP HFCs. Although numerous issues arise concerning how this phase-out should interface with the GHG control regime under the auspices of the United Nations Framework Convention on Climate Change (UNFCCC), nations should not delay action on the proposed amendment to the Montreal Protocol for the assumption of immediate control and implementation of the HFC phase-out.



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# The HFC problem

Spiralling HFC production, consumption and emissions must be addressed as a matter of urgency. Updated HFC projections indicate that without further regulation, future emissions of high-GWP HFCs will be much greater than previously anticipated. Recent research estimates that HFC emissions will reach between 5.5–8.8 gigatonnes of carbon dioxide equivalent (Gt CO<sub>2</sub>-eq.) by 2050.<sup>1</sup> These projections, published by a team of researchers led by Guus J. M. Velders of the Netherlands Environmental Assessment Agency, use similar modelling to the Intergovernmental Panel on Climate Change (IPCC) in its emission scenarios, where growth is based on gross domestic product (GDP) and population trajectories. However the new research adds a valuable new dimension as it incorporates recent information on replacement patterns of HCFCs by HFCs, as well as HCFC and HFC consumption growth in developing countries.

It is widely acknowledged that there is an urgent need to rapidly stabilise atmospheric CO<sub>2</sub> concentrations in order to reduce the catastrophic risks of global climate change. While the requisite CO<sub>2</sub> target levels are a matter of debate, there appears to be growing consensus that at a minimum a stabilization of concentrations of CO<sub>2</sub> in the atmosphere

at 450ppm (parts per million) is necessary by 2050.<sup>2</sup> Under this scenario, by 2050 HFC emissions would be between 28–45% of CO<sub>2</sub> emissions.<sup>3</sup> If left unchecked, HFC use will prove fatal to domestic and international efforts to arrest and reverse global climate change.

The responsibility for today's HFC market lies in the hands of developed countries that introduced HFCs as replacements to ODS. Predicted growth in developing country markets is due to HFCs' widespread use in established technologies in developed countries. It is essential that developed countries acknowledge this responsibility by advancing towards development of HFC-free technologies and demonstrating clear leadership in seeking to achieve a progressive and fair global HFC phase-out agreement.

## HFC GROWTH IN DEVELOPING COUNTRIES

The need for urgent action to curtail high-GWP HFC emissions is especially critical in developing (Article 5) nations where soaring market demand for refrigeration and air-conditioning is triggering a corresponding rise in consumption of HFCs. Setting a clear schedule to move from HFCs directly


to low-GWP alternatives now will ensure that these nations do not invest in an HFC cul-de-sac, requiring far more costly and difficult mitigation efforts in the future.

As HCFCs are progressively phased out in developing countries, HFCs are set to become the dominant substitutes, replacing over 75% of the historic HCFC consumption.<sup>4</sup> The Technology and Economic Assessment Panel (TEAP) estimates that between 2015 and 2020 HFC banks in developing countries will increase by 39% with emissions rising by 31%.<sup>5</sup> Research released in June 2009 by Velders and his team is even more worrying, anticipating HFC consumption in developing countries overtaking that of developed countries before 2020.<sup>6</sup>

It is imperative to avoid the transition to high-GWP HFCs by creating a framework which uses the Montreal Protocol to facilitate low-GWP

substitutes and technology transfer to developing countries. The Montreal Protocol's Executive Committee must be immediately directed to stop funding projects utilizing high-GWP HFCs where more environmentally suitable alternatives exist. A clear framework needs to be established to phase out high-GWP HFCs and prevent HFC emissions in developing countries from soaring at precisely the time that global GHG emissions need to be curtailed.

EIA is calling for an amendment of the Montreal Protocol to include HFCs in the category of controlled substances that it is mandated to phase out. In order to facilitate this amendment EIA is also calling on Parties to the Montreal Protocol to take immediate measures to avoid the transition to high-GWP HFCs and to encourage the development of low-GWP alternatives as described in the draft decision below.



## EIA suggested draft decision on immediate measures to reduce HFC consumption

Aware of the wide agreement among scientists that global climate change threatens present and future generations unless more stringent control measures are adopted;

Aware that the effects of global climate change are already impacting the global environment and that immediate action is necessary to mitigate more far reaching effects;

Mindful of the scientific consensus that climate change will delay the recovery of the ozone layer;

Recognizing that although many HFCs were commercialized primarily to replace ozone depleting substances ("ODS"), they are in fact powerful greenhouse gases contributing to global climate change;

Conscious of the need to continue the phase-out of ODS without adverse impacts to the global climate;

Mindful of the need to look for synergies to support United Nations Framework Convention on Climate Change ("UNFCCC") by avoiding the phase-in of HFCs with high global warming potential ("GWP");

Aware that the Technology and Economic Assessment Panel ("TEAP") has documented the existence of environmentally-superior substitutes for high-GWP HFCs in some sectors and the rapid technological development of low-GWP substitutes in many other sectors;

Recognizing the importance of Decision XIX/6, paragraph 11b which directs the Executive Committee to give priority to substitutes and alternatives that minimize impacts on the environment, including on the climate, taking into account GWP, energy use and other relevant factors when developing and applying funding criteria for projects and programs;

Do hereby agree to commit themselves to encourage the use of low-GWP substitutes and replacements and discourage the use of high-GWP HFCs substitutes for ODS or HCFCs where environmentally-superior substitutes and replacements exist; and to accelerate the development, evaluation, demonstration and implementation of environmentally superior alternatives and technologies with low-GWP and superior energy efficiency, in proportion to their means and resources; and further do

Call upon the Executive Committee to use its funding mechanisms to avoid funding the use of high-GWP substitutes for ODS and HCFCs where more environmentally friendly alternatives or technologies are available; and

Call upon the TEAP to evaluate emission reduction benefits arising from a high-GWP HFC phase-out.



# The case for a reduction in HFC consumption and production

Most HFCs, other than HFC-23, are intentionally produced for use in commerce and are not unwanted by-products. There are several options available to reduce high-GWP HFC emissions including: containment measures; incorporation into trading schemes; and phasing out production and consumption.

The containment approach is aimed at reducing leakage and addressing emissions at end of life. This method is a key aspect of the European Union's F-gas regulation. The regulation incorporates log book keeping, mandatory leakage checks, certain use bans and further training for refrigerant engineers.

Analysis of the conceptual underpinnings of the F-gas regulation can be drawn from the Dutch system, known as STEK. Based upon the STEK system the regulation is hoped to reduce F-gas leakage levels by 5.5% to 11% across the EU.<sup>7</sup> If successful

it is estimated that the cost of the reductions would equate to €18.32 per CO<sub>2</sub>-eq. tonne.<sup>8</sup> A study by the Institute for European Environmental Policy estimated that if leakage reduction is less than anticipated, for example 8.5%, the cost would soar to over €50 per CO<sub>2</sub>-eq. tonne,<sup>9</sup> rendering containment a very costly option.

The second option is to include HFCs in emissions trading schemes, along with the more prolific GHGs i.e. CO<sub>2</sub>, nitrous oxide and methane upon which current GHG emission reduction agreements are based. Due to their very high GWP, HFCs are generally considered to be “cheap” offsets compared to CO<sub>2</sub>, making them attractive to governments looking for the “low-hanging fruits” of climate mitigation. The experience of allowing HFC-23 into carbon markets has shown how low cost mitigation is better addressed by public funding rather than allowing the private sector to exploit these rare and key opportunities.

The last alternative is to reduce consumption and production of HFCs through a phase-out. Setting a clear regulatory framework to meet these objectives helps businesses plan ahead and gives a clear market signal for the development of alternatives. The efficacy of this approach has been demonstrated by previous Montreal Protocol phase-outs and also within the HFC mobile air-conditioning (MAC) sector by the EU's MAC Directive. Following the MAC directive there has been a flurry of investment in low-GWP alternatives. Fluorocarbon manufacturers have been developing low-GWP HFCs that they claim will be viable alternatives<sup>10</sup> and the German Automotive Industry Associate (VDA) announced that it will adopt CO<sub>2</sub> based technology.<sup>11</sup>

Not only do phase-outs send clear signals to the market but historically they have offered much more attractive cost-benefit ratios. Between 1991–2007 the phase-out of ODS by the Montreal Protocol has led to reductions of about 5.6 Gt CO<sub>2</sub>-eq. per year<sup>12</sup> and was carried out at a cost of about US \$0.025 per

tonne.<sup>13</sup> Even if this were multiplied by a factor of ten or one hundred it would still represent by far the most cost-effective form of climate mitigation available.

The TEAP already has a significant understanding of HFC-based technologies and the availability and viability of alternatives. The TEAP's most recent report "Assessment of the Alternatives to HCFCs and HFCs and Update of the TEAP Supplement Report Data", documents the availability of alternatives to HFCs across a wide variety of sectors, especially domestic refrigeration, commercial stand alone refrigeration, large industrial refrigeration and polyurethane foams.<sup>14</sup> In other sectors, alternatives are under consideration, testing and analysis. There are only a limited number of sectors where alternatives are not available or under development and they should not stand in the way of a phase-out. Experience of Montreal Protocol phase-outs has demonstrated that once regulation is in place, alternatives will follow.



## Phase-out versus phase down

EIA is calling for the phase-out of high-GWP HFCs. This would allow for the use of low-GWP HFCs should they prove to be safe for human use and to the environment. If low-GWP HFCs were included in any final agreement then EIA would support a very aggressive phase down schedule. If low-GWP HFCs were exempted from the phase-out, EIA would remind Parties that exempted chemicals need to be monitored very closely due the high risks of illegal trade using exemptions as a cover for high-GWP HFCs.



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# Why the Montreal Protocol has a responsibility to phase out HFCs

High-GWP HFCs were invented and commercialized as direct replacements for ODS. If the Montreal Protocol continues to condone the use of high-GWP HFCs the result would conflict with the treaty's precautionary and holistic approach to phasing out ODS over its 21-year-history.

It is essential that Parties to the Montreal Protocol accept their responsibility by taking all possible measures to reduce HFC emissions by: promoting development of low-GWP alternatives; directing the Executive Committee to stop funding the use of high-GWP HFCs where suitable low-GWP alternatives exist; encouraging the development of new low-GWP alternatives; and setting up a regulatory framework to phase-out the production and consumption of high-GWP HFCs.

Actions of the Parties to the Vienna Convention for the Protection of the Ozone Layer (Vienna Convention) have been aimed at modifying the ozone layer in order to reduce the damaging effects of ozone thinning on human health.

The Montreal Protocol's success in addressing a serious environmental threat is unparalleled, as was most recently demonstrated by the agreement to accelerate the phase-out of HCFCs in 2007. However, without clear direction from Parties concerning the appropriate substitutes for HCFCs, it is very likely that the HCFC phase-out will have a negative net climate impact.<sup>16</sup> The preamble to the Vienna Convention recognizes that Parties are "...determined to protect human health and the environment against adverse effects resulting from modifications of the ozone layer." The Parties are therefore obliged to protect the environment from climate change effects resulting from ODS phase-outs.

This obligation was reiterated at the July 2008 G8 Leaders Meeting of Major Economies on Energy Security and Climate Change when they reaffirmed their commitment to helping the climate through the Montreal Protocol by declaring: "...recognizing the need for urgent action...we commit to...actions under the Montreal Protocol on

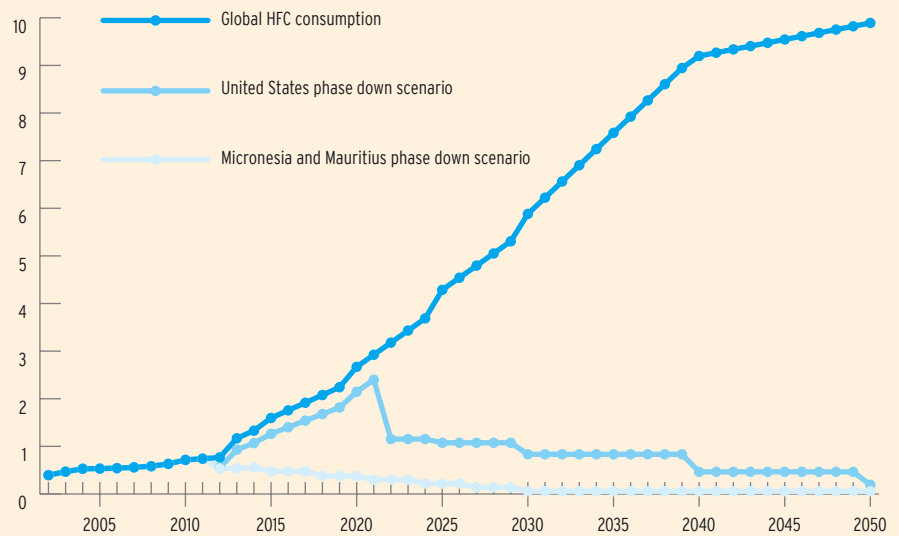
Substances that Deplete the Ozone Layer for the benefit of the global climate system.”

One of the key driving forces behind the accelerated HCFC phase-out agreement was the enormous climate benefits it has the potential to offer; up to 16 Gt CO<sub>2</sub>-eq. by 2040.<sup>16</sup> However, if HFCs are the dominant replacements for HCFCs then not only will this saving be lost but the result could actually be a net negative climate impact.<sup>17</sup> Replenishment for the period 2009–2011 at the 20th Meeting of the Parties in Doha totaled US\$480million, the majority of which will be used to meet HCFC phase-out requirements.<sup>18</sup> It would be a shocking waste of public funds if this money were spent to promote activities which may have overall detrimental impacts on global warming, particularly during the present economic downturn. It would also be a wasted opportunity if the enormous potential climate benefits of the accelerated HCFC phase-out were not reinforced by action on HFCs. Going forward, it would be far more effective to use the Multilateral Fund (MLF) in synergy with the needs of the UNFCCC by promoting alternatives to HCFCs that are both low GWP and energy efficient.

Close involvement of Montreal Protocol bodies is essential to ensure compliance with an international phase-out. Illegal trade in ODS was one of the unforeseen consequences of differential phase-out schedules between developed and developing countries. Lack of enforcement of the phase-out regulations intended led to a substantial black market in ODS, which at its peak was estimated to be worth \$25–60 million a year. In response to this illegal trade the Montreal Protocol has established a licensing system to monitor the flow of ODS. Although information sharing and cross checking of licensing systems remains weak, the proper implementation of this system has the potential to dramatically reduce illegal trade. A phase-out of high-GWP HFCs would inevitably increase incentives for illegal trade in HFCs. Without the Montreal Protocol’s close involvement in an HFC phase-out, illegal trade could spiral out of control costing economies all over the world many millions of dollars.

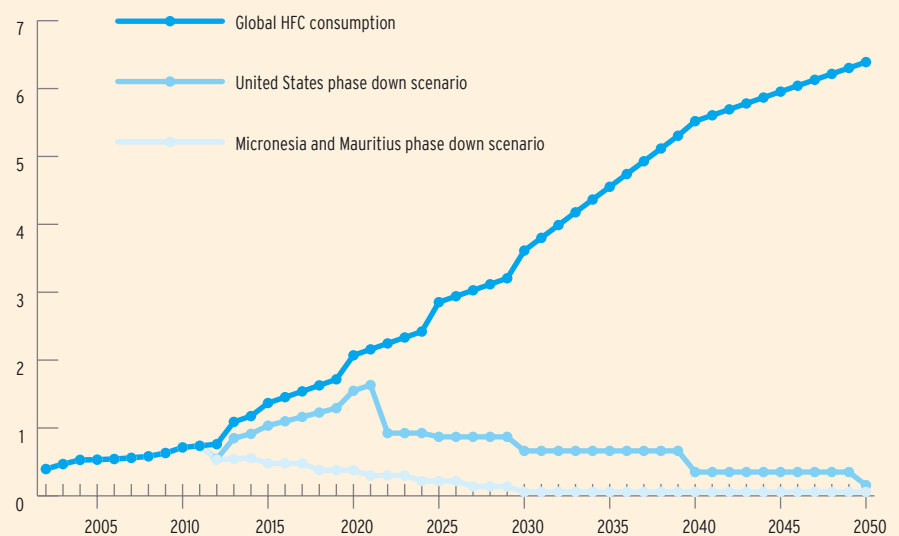
In order to enable the Montreal Protocol to play its much needed role in phasing out HFCs, Parties should agree to an amendment to add HFCs to controlled substances under the Montreal Protocol. Such an amendment to the Montreal Protocol would also be consistent with the Vienna Convention for the Protection of the Ozone Layer.<sup>19</sup>

**Figure 1.**  
**Global high end HFC consumption projections compared to phase down scenarios**



This graph is based on new baseline HFC consumption projections (A1 scenario) according to Velders *et al.* 2009 and has been replicated with kind permission of the authors. HFC consumption is given in GtCO<sub>2</sub> eq.

**Figure 2.**  
**Global low end HFC consumption projections compared to phase down scenarios**



This graph is based on new baseline HFC consumption projections (A2 scenario) according to Velders *et al.* 2009 and has been replicated with kind permission of the authors. HFC consumption is given in GtCO<sub>2</sub> eq.

**Table 1.**  
**Projected aggregate HFC consumption reductions from two phase down scenarios**

All units GtCO <sub>2</sub> eq.	High-end HFC consumption projections	Low-end HFC consumption projections
Aggregate HFC consumption scenarios 2010-2050	233	149
Potential savings resulting from Micronesia and Mauritius Proposal	224	140
Potential savings resulting from US Communication	195	118


(see below for assumptions used in analysis)

## CURRENT PROPOSAL TO AMEND THE MONTREAL PROTOCOL

In May this year Micronesia and Mauritius submitted a proposal to “Amend and Strengthen the Montreal Protocol on Substances that Deplete the Ozone Layer to Regulate Hydrofluorocarbons”. The rationale behind the proposed amendment was to preserve the climate mitigation benefits of the HCFC accelerated phase-out, as well as achieve further climate mitigation benefits. The proposal puts forward consumption phase down schedules for A5 and non-A5 Parties. Figures 1 and 2

demonstrate the effect the proposed phase down would have using recently published HFC projected emissions according to two business as usual (BAU) scenarios. The considerable climate benefits of the proposed amendment are clear; EIA’s analysis of the data indicates that between 2010 and 2050 the phase down proposed by Micronesia and Mauritius could achieve between 140–224Gt CO<sub>2</sub>-eq. savings, based on the two BAU scenarios (see Table 1). The significance of this proposal is underlined by the fact that the very existence of these low lying island states is threatened by climate change.

In response to the Micronesia and Mauritius proposal the US Department of State issued a communication to the Ozone Secretariat acknowledging the future climate threat of increasing HFC emissions and the need to phase down their consumption. The communication also offers details of a US Environmental Protection Agency HFC phase down analysis, the possible emission reduction effects of which are also documented in Figures 1 and 2. Table 1 indicates that this phase down scenario could save 118-195 GtCO<sub>2</sub>-eq between 2010 and 2050.



## HFC phase down analysis

The EIA analysis in Figures 1 and 2 and Table 1 is intended to provide an illustrative basis for comparison of two proposals for phasing down HFCs. HFC consumption data is taken from Figure 1B in the recent paper by Guus Velders and his team “The large contribution of projected HFC emissions to future climate forcing” and is based on assumptions used in IPCC A1 and A2 scenarios.<sup>20</sup>

Proposals and communications to the Secretariat from Parties are understood to be the following:

<p><b>Micronesia and Mauritius Proposal</b>            Baseline average 2004, 2005, 2006            Freeze 2012</p> <p><b>Reduction steps</b>            2015 – 15%, article 5 countries allowed 10% extra production            2018 – 30%, article 5 countries allowed 10% extra production            2021 – 45%, article 5 countries allowed 10% extra production            2024 – 60%, article 5 countries allowed 10% extra production            2027 – 75%, article 5 countries allowed 10% extra production            2030 – 90%, article 5 countries allowed 10% extra production</p>	<p><b>United States Communication</b>            Baseline average 2004, 2005, 2006            Freeze 2012</p> <p><b>Reduction steps</b>            10% 2015            25% 2020            50% 2030            85% 2040            10 year grace period for Article 5 countries</p>
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## Benefits for developing countries

It is clear that the biggest challenge in addressing HFCs will be in developing countries. With the consequences of climate change increasingly apparent, the challenge for Article 5 countries is how they can develop and allow their economies to prosper within an increasingly low carbon regime. This task may be daunting, but leapfrogging high-GWP HFC technology to more climate friendly alternatives where possible is one of the easiest options available and will save Article 5 countries immense costs in the long term.

Article 5 countries must be given financial assistance to enable them to avoid the transition to high-GWP HFCs and to phase-out existing high-GWP HFC use. If developing countries miss this vital climate mitigation opportunity, it is unclear whether another round of financial assistance will be available in the near future to phase-out large scale high-GWP HFC use.

An HFC phase-out at this stage would not conflict with the HCFC phase-out. Any agreement reached on phasing out HFCs should be based on a clear understanding of the availability of alternatives. Under the terms of paragraph 5 of Article 5 of the Montreal

Protocol on the special situation of developing countries, a phase-out of HFCs by Article 5 Parties will only have to go as far as the technology and financing allows. History has shown that regulation leads to innovation. If developed countries adopt an earlier schedule to phase-out HFCs than developing countries, as has been the case with all previous Montreal Protocol phase-outs, the differential period will allow for the development of even more low-GWP substitutes and technologies which can be implemented in Article 5 countries.

### LINKING TO UNFCCC

Amending the Montreal Protocol to enable it to phase-out HFCs does not necessarily mean that emissions of HFCs can no longer be the responsibility of UNFCCC and its Kyoto Protocol. Article 3 of the Kyoto Protocol lists control measures for Annex A gases, a category that includes HFCs. Should Parties wish, a phase-out under the Montreal Protocol could be used to comply with Kyoto Protocol GHG reduction commitments by Annex 1 countries. Furthermore a phase-out could be considered as appropriate mitigation actions under the Bali Action Plan.

Reporting of HFC emission reductions resulting from a phase-out can be done in a measurable, reportable and verifiable manner via the TEAP. Under an amendment, production and consumption of HFCs could be measured in terms of CO<sub>2</sub>-eq tonnes. This would be reduced from the baseline year according to an agreed reduction schedule, from which national emission reductions could also be estimated. Alternatively, HFC emissions could continue to be reported based on IPCC guidelines for national GHG inventories.<sup>21</sup>

At the current time there is uncertainty surrounding the successful outcomes of the UNFCCC Copenhagen climate talks. A fair and equitable agreement to take early action to phase-out the production and consumption of HFCs and the associated long term reduction in HFC emissions could prove to be an essential trust and confidence builder in the lead up to Copenhagen and beyond.

In simplistic terms the climate talks may be characterised as focusing on the need for effective technology transfer and financial mechanisms, strong emission reduction commitments from developed countries and robust nationally appropriate mitigation actions (NAMAs) by developing countries. Technology transfer and financial

mechanisms of the Montreal Protocol may be useful for application within UNFCCC; submissions by developing countries to the Ad Hoc Working Group on Long-term Co-operative Action (AWG-LCA) have suggested the need for the establishment of a multilateral fund, technical panels and use of incremental cost models.<sup>22</sup> An agreement to phase-out high-GWP HFCs under the Montreal Protocol will add weight to the argument that aspects of the Montreal Protocol's technology transfer and financial mechanisms should be incorporated into the UNFCCC Agreed Outcome.

Regardless of any global HFC phase-out agreement, the future for high-GWP HFCs in developed country markets is limited. As commitments to reduce GHG emissions of the basket of Kyoto gases become tighter and tighter there will inevitably be a shift towards low-GWP technologies. Furthermore the EU, through its F-gas regulation, and the US, through its Waxman-Markey climate bill which will phase down consumption of HFCs including those imported in equipment, have sent strong signals that they want low-GWP alternatives.

Many developing countries have industries exporting HFCs and equipment containing HFCs to developed countries. In the not so distant future,

it is likely that the demand for these products in developed countries will decrease dramatically as these countries commit to ever increasing emissions reductions. It therefore makes sense to take advantage of funding mechanisms which may assist developing countries to anticipate trends in the global market.

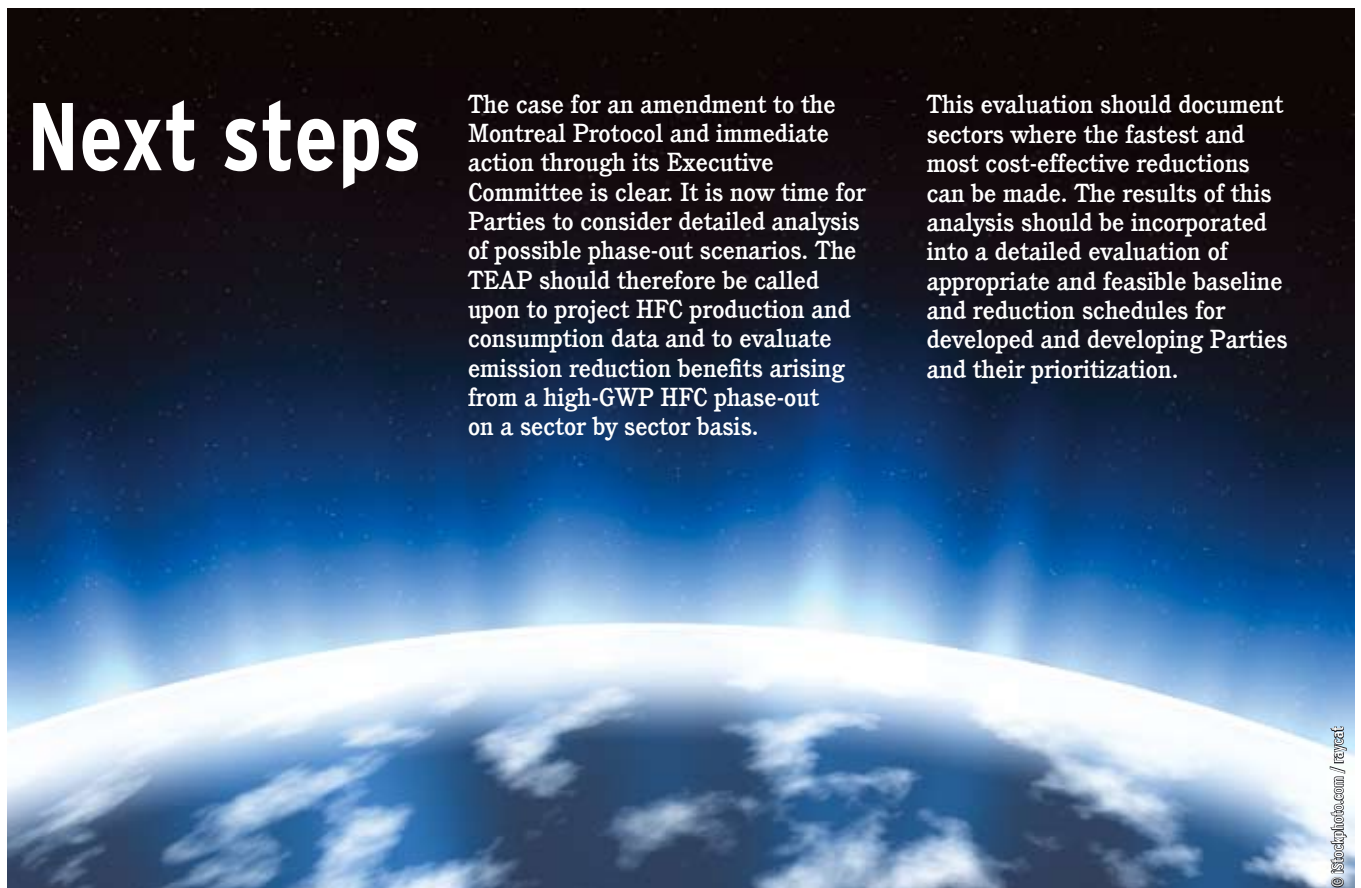
## ACCOUNTING FOR EARLY ACTION

In order to meet its first Kyoto Protocol commitment period reductions in GHGs, the European Union introduced its F-gas regulation which is aimed at reducing HFC emissions primarily through containment and a MAC Directive which will phase-out the use of high-GWP HFCs in mobile air-conditioning starting in 2011. This kind of early action would be recognized in the proposal put forward by Micronesia and Mauritius and the Communication submitted by the US with regard to a proposed amendment to the Montreal Protocol. Both the Proposal and the Communication suggest a baseline that is the average of 2004, 2005, 2006 consumption. The EU F-gas regulation came into force in 2007, and is just beginning to be implemented, so will be a useful tool in meeting any future agreed phase-out with baseline dates previous to 2009.

## Next steps

The case for an amendment to the Montreal Protocol and immediate action through its Executive Committee is clear. It is now time for Parties to consider detailed analysis of possible phase-out scenarios. The TEAP should therefore be called upon to project HFC production and consumption data and to evaluate emission reduction benefits arising from a high-GWP HFC phase-out on a sector by sector basis.

This evaluation should document sectors where the fastest and most cost-effective reductions can be made. The results of this analysis should be incorporated into a detailed evaluation of appropriate and feasible baseline and reduction schedules for developed and developing Parties and their prioritization.





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# Conclusion

The mitigation potential for avoiding an irreversible tipping point on climate through expedited high-GWP HFC phase-out is a unique opportunity. There simply is no other comparable prospect for climate mitigation by the international community that remotely compares in terms of practical or fiscal ease and achievability. As such, the opportunity that exists for transitioning from ODS gases directly to low-GWP alternatives using Montreal Protocol mechanisms is one that humanity cannot afford to miss.

# Recommendations

- Parties should immediately direct the Executive Committee to adopt a presumption against HFCs where low-GWP alternatives exist;
- Parties should adopt an amendment to the Montreal Protocol which adds HFCs to controlled substances;
- TEAP should be asked to produce future HFC consumption and production projections and to commence preparing phase-out scenarios as soon as possible.

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