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Thirty-fifth meeting
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Overview of issues related to hydrofluorocarbons and their management

Note by the Secretariat

I. Introduction

1. The Twenty-Sixth Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer adopted decision XXVI/9, on the report by the Technology and Economic Assessment Panel on information on alternatives to ozone-depleting substances (October 2014 Technology and Economic Assessment Panel task force final report on decision XXV/5, "Additional Information on Alternatives to ozone-depleting substances"[1] [2]). In paragraph 2 of the decision the parties decided to convene a two-day workshop, back to back with a three-day meeting of the Open-ended Working Group in 2015, to continue discussions on all issues in relation to the management of hydrofluorocarbons (HFCs), including a focus on high-ambient temperature and safety requirements as well as energy efficiency, taking into account information to be provided in a report by the Technology and Economic Assessment Panel in accordance with paragraph 1 of the decision and other relevant information.

2. The report to be prepared by the Panel is to, among other things, identify the full range of alternatives to ozone-depleting substances, including not-in-kind technologies, identifying applications for which appropriate alternatives are not available and elaborating on energy efficiency levels in the refrigeration and air-conditioning (RAC) sector, in particular for high-ambient temperature zones, including in terms of international standards. The Panel was also requested, taking into account the uptake of various existing technologies, to revise the scenarios for current and future demand elaborated in its October 2014 final task force report on decision XXV/5 and to improve the information in that report related to costs and benefits, including with regard to progress identified under stage I and stage II of the hydrochlorofluorocarbon (HCFC) phase-out management plans of parties to the Montreal Protocol. The report is to be made available for consideration by the Open-ended Working Group at its thirty-sixth meeting in July 2015; an updated report is thereafter to

[1] http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/TEAP_Task%20Force%20XXV5-October2014.pdf.

[2] A list of the reports referred to in the present note is set out in annex I.

be submitted to the Twenty-Seventh Meeting of the Parties with the understanding that a presentation on the report will be made at the thirty-fifth meeting of the Open-ended Working Group in April 2015.

Scope of the present note

3. The present note aims to provide a summary of key information pertaining to hydrofluorocarbons (HFCs) and their management, which the parties may wish to take into consideration in their deliberations during the thirty-fifth meeting of the Open-ended Working Group. The summary is based on parties' discussions on HFC-related issues to date and recent information provided by the Scientific Assessment Panel, the Technology and Economic Assessment Panel and the Secretariat of the Multilateral Fund for the implementation of the Montreal Protocol, as well as by institutions under the United Nations Framework Convention on Climate Change and other international initiatives dealing with HFCs. The present note consists of the following sections:

I. Introduction

II. Historical account of the ozone-climate nexus

III. Reporting by the Technology and Economic Assessment Panel on alternatives to high-global-warming-potential HFCs

IV. Global levels of HFCs

V. Regulatory frameworks, policy measures and initiatives to control HFCs

VI. Discussions on proposed approaches to controlling HFCs under the Montreal Protocol

VII. Funding by the Multilateral Fund for the transition to climate-friendly alternatives

VIII. Funds approved under the ozone and climate financial regimes

4. The document also includes the following annexes:

Annex I - Technology and Economic Assessment Panel reports on alternatives to high-global-warming-potential HFCs

Annex II - Data on emissions, production and consumption of HFCs reported by parties listed in Annex I to the United Nations Framework Convention on Climate Change

Annex III – Discussions on proposed approaches to controlling HFCs under the Montreal Protocol - views expressed by resource persons and observers.

5. The Secretariat wishes to express its appreciation to the Scientific Assessment Panel, the Technology and Economic Assessment Panel, the Secretariat of the Multilateral Fund, the secretariat of the Framework Convention on Climate Change, the Climate and Clean Air Coalition and the Climate and Technology Centre for their valuable contributions to the preparation of the present note.

II. Historical account of the ozone-climate nexus

6. Throughout the history of the implementation of the Montreal Protocol, parties have been searching for viable alternatives to controlled ozone-depleting substances due for phase-out. Decisions on the adoption of such alternatives have been guided by information on alternatives provided annually and quadrennially by the Technology and Economic Assessment Panel, supplemented by quadrennial updates on the science and the environmental impacts of ozone depletion by the Protocol's Scientific Assessment Panel and Environmental Effects Assessment Panel.

7. Friendliness to the ozone layer has historically been the major consideration in the search for alternatives to ozone-depleting substances. Concerns about climate impact of those alternatives, however, have become an important additional consideration, and the adoption of the Kyoto Protocol to the Framework Convention on Climate Change in 1997 reinforced the need to consider how to achieve a transition to ozone-depleting substance alternatives that are both ozone-friendly and climate-friendly**.**

8. The Nineteenth Meeting of the Parties to the Montreal Protocol, in September 2007, adopted decision XIX/9, by which it decided, by way of an adjustment to the Protocol, to accelerate the phase-out of global production and consumption of HCFCs under paragraph 9 of Article 2 of the Protocol. With the global phase-out of chlorofluorocarbons (CFCs) in 2010 and the accelerated global phase-out of HCFCs, the use of HFCs as replacement substances increased substantially worldwide. Although they do not deplete the ozone layer, most HFCs are powerful greenhouse gases. Their

increasing use has therefore raised concerns by parties and led to discussions on the propriety of their use and how to avoid it.

9. In fact, discussions on how to avoid the use of HFCs as alternatives to ozone-depleting substances have a long history. In 1998 the parties to the Montreal Protocol sought to understand the implications that actions under the Kyoto Protocol to control HFCs (and perfluorocarbons (PFCs)) could have on their efforts to implement the Montreal Protocol. This led to the adoption of decision X/16 by the Tenth Meeting of the Parties to the Montreal Protocol, in November that year, on the implementation of the Montreal Protocol in the light of the Kyoto Protocol. In line with decision 13/CP.4, adopted by the Conference of the Parties to the Framework Convention on Climate Change at its fourth meeting earlier that month (entitled "Relationship between efforts to protect the atmospheric ozone layer and efforts to safeguard the global climate, in particular with reference to HFCs and PFCs"), decision X/16 called, inter alia, for a joint workshop by the Intergovernmental Panel on Climate Change (IPCC) and the Technology and Economic Assessment Panel on options for limiting emissions of HFCs and PFCs. Those issues were subsequently addressed at an Expert meeting organized by IPCC and the Panel in 1999 in Petten, the Netherlands.

10. At its eighth meeting, in October 2002, the Conference of the Parties to the Framework Convention on Climate Change, mindful of the role of the use of HFCs in the phase-out of ozone-depleting substance adopted decision 12/CP.8, by which it invited IPCC and the Technology and Economic Assessment Panel to prepare a balanced scientific, technical and policy-relevant special report by early 2005. In the same decision parties were encouraged "to ensure that their actions to address ozone depletion are undertaken in a manner that also contributes to the objectives of the Montreal Protocol and the Convention" and "to work towards continued research and development on technologies that safeguard the ozone layer while at the same time contributing to the objectives of the Montreal Protocol and the Convention". Governments were also encouraged "to engage in or continue dialogues with industries and stakeholders to advance information regarding replacement options for ozone-depleting substances in a manner that contributes to the objectives of the Montreal Protocol and the Convention".

11. One month later, in November 2002, the Fourteenth Meeting of the Parties to the Montreal Protocol adopted decision XIV/10, in which it welcomed decision 12/CP.8 and requested the Technology and Economic Assessment Panel to work with IPCC in preparing the above-mentioned report. In response, the Panel and IPCC prepared a joint assessment entitled "Special Report on Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons". The special report was followed by a 2005 supplementary Panel report elaborating on the ozone depletion implications of the issues raised in the special report and in 2006 the Panel compiled a list of practical measures relating to ozone depletion that arose from the special report and the supplementary report, along with information on associated costs and environmental benefits, including those relating to climate change.

12. The 2007 decision to accelerate the phase-out of HCFCs by the parties to the Montreal Protocol (decision XIX/6) led to a number of further decisions calling for more clarity on the availability of viable alternatives to HCFCs. In particular, decision XIX/8 requested the Technology and Economic Assessment Panel to undertake a scoping study on the prospects for the promotion and acceptance of alternatives to HCFCs in the refrigeration and air-conditioning sector in parties operating under paragraph 1 of Article 5 (Article 5 parties), taking due consideration of the specific climatic and unique operating conditions in some countries. In a series of subsequent decisions the Panel was requested to provide comprehensive and additional information on various aspects of environmentally sound alternatives to HCFCs (see section III below).

13. In addition to addressing HFC-related issues at their regular meetings, parties to the Montreal Protocol discussed them extensively at three major workshops: A workshop on the IPCC/Panel special report, held in Montreal in July 2006 in response to decision XVII/19 (2005); a workshop on high-global-warming-potential alternatives to ozone-depleting substances, held in Geneva in July 2009 in response to decision XX/8 (2008); and a workshop on hydrofluorocarbon management, held in Paris in July 2014 in response to decision XXV/5 (2013). A fourth workshop to be convened prior to the thirty-fifth meeting of the Open-ended Working Group of the parties to the Montreal Protocol, called for in decision XXVI/9 (2014), is expected to provide further information, primarily on technical issues related to HFC management.

III. Reporting by the Technology and Economic Assessment Panel on alternatives to high-global-warming-potential HFCs

14. As mentioned above, over the years the Meeting of the Parties has requested the Technology and Economic Assessment Panel to provide information on HFC-related issues including issues pertaining to alternatives to high-global-warming-potential (GWP) HFCs. In response to its mandates the Panel prepared a number of comprehensive reports on climate friendly alternatives to ozone-depleting substances addressing important issues such as commercial availability, technical feasibility, adequate energy efficiency, environmental and economic viability, cost effectiveness and safety requirements. Alternatives to HCFC refrigerants under high ambient temperatures were also addressed in two scoping studies (presented to the parties in 2008 and 2010, respectively) while issues related to the management of HFC banks were included in several reports by the Panel over time.

15. Noting again that the Technology and Economic Assessment Panel will soon be providing further information in response to decision XXVI/9, and that the April 2015 workshop will offer to parties opportunities to engage in in-depth discussions on technical aspects related to the adoption of low-GWP alternatives to HFCs, the Secretariat lists in annex I to the present note the major relevant technical assessment reports produced to date in response to decisions by the Meeting of the Parties. Parties may wish to refer to those reports for detailed information on the issues under discussion, along with the Panel report on alternatives to ozone-depleting substances requested in decision XXVI/9, a preview of which is to be presented to the current meeting.

IV. Global levels of HFCs

16. HFCs are man-made fluorinated chemicals that do not deplete the ozone layer but are potent greenhouse gases. Due to their ozone-layer friendliness, HFCs have been used as replacements for many ozone-depleting substances including CFCs, halons and HCFCs in the air-conditioning, refrigeration, foam-blowing, fire suppression, solvent and aerosol sectors. One HFC, HFC-23, is mostly an inadvertent byproduct of HCFC-22 production, with limited use in other applications.

17. Emissions of HFCs originate from manufacturing processes, unintended by-product releases, intentionally emissive applications and evaporation and leakage from equipment and products during use, testing, maintenance and end-of-life practices.

18. Historical trends in global HFC levels indicate substantial increases over recent decades, while estimates project similar increases in the future under business as usual scenarios. Without intervention, the increase in HFC emissions in the future (say by 2050) could offset much of the climate benefit achieved by earlier reductions in ozone-depleting substances.[3]

19. An updated picture of trends in HFC levels is provided in the December 2014 report entitled "Scientific Assessment of Ozone Depletion: 2014"[4] (the "2014 scientific assessment report") and the October 2014 report by the Technology and Economic Assessment Panel entitled "Decision XXV/5 Task Force Report: Additional Information to Alternatives on ODS". Key elements of those reports, along with relevant information provided by the secretariat of the Framework Convention on Climate Change and findings included in later published peer-reviewed articles are presented below.[5]

A. Emissions and atmospheric abundances of HFCs

20. At the **national** level, disaggregated data on annual HFC emissions in developed countries and countries with economies in transition listed in Annex I to the Framework Convention on Climate Change (Annex I parties) are available in the records held by that Convention's secretariat in its open database. The emissions of HFCs reported by Annex I parties are reviewed regularly by expert review teams to establish their reliability. Reported emission figures are displayed for specified years in table 1 of annex II to the present note. The data show that with the exception of two Annex I countries that reduced their HFC emissions by 2012 compared to the base year levels, large increases have been reported by all other countries over time. For developing countries not listed in Annex I to the Framework Convention on Climate Change (non-Annex I parties), reported emission data are scarce

[3] "HFCs: A Critical link in protecting Climate and the Ozone Layer - A UNEP Synthesis Report" (2011).

[4] http://ozone.unep.org/en/scientific_assessment_2014.php.

[5] There will be more papers appearing in the literature in the coming year quantifying emissions of various HFCs from different parts of the world. Such papers are already available in preprint form but are not included here because they are not yet in the published literature.

and not subject to expert review. According to the Framework Convention on Climate Change secretariat, any such data that may have been reported can be found in the national communications reports submitted by non-Annex I parties (see also section V B 1 below).

21. At the **regional** level, the 2014 scientific assessment report notes that emissions can be assessed either by extracting information from globally distributed measurements or by using measurements from source regions. The report provides regional emissions estimates for some HFCs. Emissions of HFC-134a, for example, are estimated to be highest in Asia and the United States of America, followed by Europe, comprising 29, 28 and 17 per cent of global emissions, respectively.[6] Current emissions of HFC-23 occur foremost in East Asia while the United States is currently the world's most important source of HFC-152a emissions. More recent studies updating the data on emissions of various HFCs from different parts of the world reveal no major differences from the Scientific Assessment Panel's assessment of the situation.

22. At the **global** level, atmospheric abundances of the most important HFCs are increasing as shown in figure 1. According to the 2014 WMO/UNEP assessment report the most abundant HFC, HFC-134a, reached a mole fraction of nearly 68 parts per trillion (ppt) in 2012, with an increase of 5 ppt per year (7.6 per cent) during 2011–2012. HFC-125, HFC-143a and HFC-32 have similar or even higher growth rates than HFC-134a, but their current abundances are considerably lower. Based on atmospheric measurements, using data on their atmospheric lifetimes, global emissions of all relevant HFCs have been calculated. Those emissions are increasing as shown in figure 2.

Figure 1
Atmospheric abundances of major HFCs (in parts per trillion)

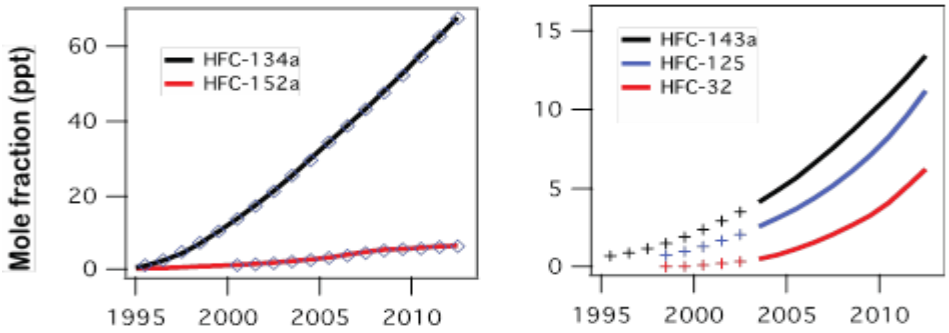
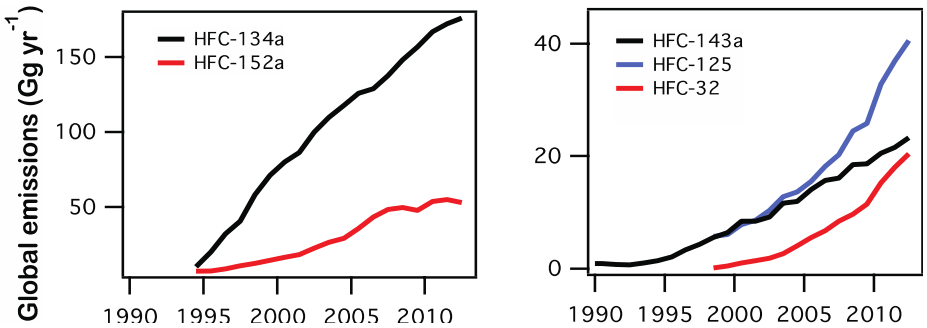


Figure 2
Global emissions of major HFCs (in Gigagrams per year)



23. Emissions of CFCs, HCFCs and HFCs, in terms of their influence on climate (expressed in Gigatonnes of CO_2-equivalent emissions), were roughly equal in 2012. Emissions of HFCs are currently increasing rapidly, however, while emissions of CFCs are decreasing and those of HCFCs remain essentially unchanged for the time being.[7] The HFC increase partially offsets the decrease in

[6] Stohl and others "An analytical inversion method for determining regional and global emissions of greenhouse gases: Sensitivity studies and application to halocarbons", Atmos. Chem. Phys. (2009).

[7] The 100-year GWP-weighted emissions for the sum of CFC, HCFC and HFC emissions totalled 2.2 Gt CO_2-equivalent in 2012. The sum of GWP-weighted emissions of CFCs was 0.73 ± 0.25 Gt CO_2-equivalent in 2012 and has decreased on average by 11.0 ± 1.2 per cent per year from 2008 to 2012. The sum of HCFC emissions was 0.76 ± 0.12 Gt CO_2-equivalent in 2012 and has been essentially unchanged between 2008 and 2012.

CFCs. Current emissions of HFCs are, however, still less than 10 per cent of the peak CFC emissions in the early 1990s (>8 Gt CO_2-equivalent per year). The sum of HFC emissions was 0.69 ± 0.12 Gt CO_2-equivalent in 2012 and has increased on average by 6.8 ± 0.9 per cent per year from 2008 to 2012.

24. Worldwide emissions of HFC-23, a potent greenhouse gas and by-product of HCFC-22 production, reached a maximum of ~15 Gg in 2006, decreased to ~9 Gg in 2009 and then increased again to ~13 Gg per annum in 2012. While efforts in non-Article 5 parties mitigated an increasing portion of HFC-23 emissions through 2004, a temporary decrease in emissions between 2005 and 2010 is qualitatively consistent with increased mitigation of HFC-23 emissions from Article 5 parties after 2006 under under the Clean Development Mechanism (CDM) of the Kyoto Protocol (see also section V B 3, below). The average global mole fraction of HFC-23 reached 25 ppt in 2012, with an increase of nearly 1 ppt per annum between 2010 and 2012. Between 2005 and 2010, HFC-23 emissions did not continue to increase despite continued increases in total global HCFC-22 production.

25. A new study by Montzka *et al* (2014),[8] released after publication of the 2014 scientific assessment report, is to similar effect. Based on atmospheric measurements of all HFCs except HFC-23, the study shows that between 2010 and 2012 emissions of those HFCs grew at the rates mentioned in the 2014 scientific assessment report, which are roughly in line with the projections by Velders *et al* (2009).[9] Another noteworthy conclusion of Montzka *et al* (2014) is that HFC emissions by non-Annex I parties (developing countries), not required to be reported under the Framework Convention on Climate Change, are probably equal to emissions from Annex I parties reported under the Convention. According to the Scientific Assessment Panel's 2014 report this is not surprising since HFC usage is expected to increase rapidly in non-Annex I parties.

26. The 2014 scientific assessment report provides updated information on the climate metrics used for evaluating the climate effects of greenhouse gases. Of specific interest are the updated values for their global warming potential[10] and recent values for their global temperature change potential (GTP).[11] Global warming potential and global temperature potential for the relevant HFCs are shown in table 1 below.

Table 1
Global warming and global temperature potentials

Substance	IPCC fifth assessment report 100-yr GWP	Updated 100-yr GWP *(90% uncertainty range)*	Updated 100-yr GTP
HFC-23	12400	12500 (8880–16300)	12800
HFC-32	677	704 (453–1070)	98
HFC-125	3170	3450 (2230–5140)	1180
HFC-134a	1300	1360 (857–2050)	214
HFC-143a	4800	5080 (3460–7310)	2830
HFC-152a	138	148 (96-211)	21

27. With regard to **future trends**, use and emissions of all HFCs are projected to grow rapidly. Indeed, if the current mix of HFCs remains unchanged, the 2014 scientific assessment report predicts that by 2050 GWP-weighted emissions of HFCs will be roughly comparable to the peak emissions of CFCs in the late 1980s. Projected emissions from Article 5 and non-Article 5 parties are also noted in the assessment.

[8] S. A. Montzka and others, "Recent Trends in Global Emissions of Hydrochlorofluorocarbons and Hydrofluorocarbons: Reflecting on the 2007 Adjustments to the Montreal Protocol", J. Phys. Chem. (2014).

[9] Velders and others, "The large contribution of projected HFC emissions to future climate forcing" Proc. Natl. Acad. Sci. United States (2009), 106, 10949.

[10] Global warming potential (GWP) is an index, based upon the radiative properties of well-mixed greenhouse gases, that measures the radiative forcing of a unit mass of a given well-mixed greenhouse gas in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide. GWP represents the combined effect of the differing lengths of time that these gases remain in the atmosphere and their relative effectiveness in absorbing outgoing thermal infrared radiation. The Kyoto Protocol is based on GWPs from pulse emissions over a 100-year time frame.

[11] Global temperature potential (GTP) is a new relative emission metric, defined as the ratio between the global mean surface temperature change at a given future time horizon following an emission (pulse or sustained) of a compound relative to a reference gas (e.g., CO_2).

28. While HFCs are currently estimated to cause less than 1 per cent (0.02 W m^{-2}) of the total radiative forcing of the Earth's climate, or about 2.3 watts per square metre (W m^{-2}), if the current mix of HFCs is unchanged, increasing demand could result in radiative forcing from HFCs as high as 0.4 W m^{-2} by 2050.[12] Scenarios based on projections of HFC markets yield radiative forcings that range from 0.16 W m^{-2} to 0.4 W m^{-2} by 2050. Recent atmospheric measurements (e.g., Montzka *et al*, 2014) are consistent with the faster predicted HFC emission increases.

29. Replacing the current mix of high-GWP HFCs with low-GWP compounds could lead to a decrease in radiative forcing of the climate over the coming decades, possibly by as much as 0.07 W m^{-2} by 2030 relative to baseline scenarios. By 2050, radiative forcing from low-GWP replacement compounds, if used in place of the currently used high-GWP HFCs, would be negligibly small. For the uses projected, such replacements are also likely to have a negligible effect on stratospheric ozone.

30. Not only HFC emissions but also HFCs contained in existing refrigeration and air-conditioning equipment, chemical stockpiles, foams, and other products, known collectively as "HFC banks", pose a problem for the future. If left in place, these banks may need to be destroyed in the future to eliminate their influence on the climate.

31. If currently used HFCs were to be replaced by low-GWP compounds and not-in-kind technologies, HFCs would not pose a significant threat to the climate system. The use of the current mix of HFCs may be avoided by various means, such as using substitutes with low or zero GWP and not-in kind technologies. Among the low-GWP candidates are the hydrofluoro-olefins (HFOs). One HFO is HFO-1234yf, which is already becoming available. This compound breaks down in the environment into trifluoroacetic acid (TFA), as do several other fluorocarbons currently in use such as perfluoro ketones, and increases the concentration of TFA in the hydrosphere. TFA is a persistent toxic chemical; nonetheless, it was estimated that if HFO-1234yf were used in place of all HFC-134a that is currently in use, TFA concentrations would not pose a problem (see also the 2014 assessment report of the Environmental Effects Assessment Panel[13]). The 2014 scientific assessment report noted, however, that potential longer-term problems posed by TFA and similar compounds warrant evaluation, especially when we consider the large projected increase in their use.[14]

B. Production and consumption of hydrofluorocarbons

32. At the **national** level, disaggregated annual data on production and consumption of HFCs in developed countries and countries with economies in transition – Annex I parties under the Framework Convention on Climate Change – are recorded in that Convention's database. These data are included in national inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases that Annex I parties are required to submit to the Convention secretariat annually. As mentioned earlier, reported data are reviewed by specialized expert review teams to establish their reliability. For developing country parties, however, only a small amount of data is available, through national communications reports submitted to the secretariat on an occasional basis and the accuracy of that information is not verified.

33. For the purposes of this document, data for individual HFC components have been aggregated to derive total HFC levels, and the total production and consumption figures reported by Annex I parties for specified years in the period 1990–2012 are displayed in tables 2 and 3 of Annex II to the

[12] For all scenarios used in the recent IPCC assessments (Special Report on Emissions Scenarios (SRES) and Representative Concentration Pathway (RCP)), the HFC radiative forcing increases by 0.1 W m^{-2} or less by 2050; those scenarios, however, did not consider recent market trends.

[13] See also http://ozone.unep.org/Assessment_Panels/EEAP/eeap_report_2014.pdf.

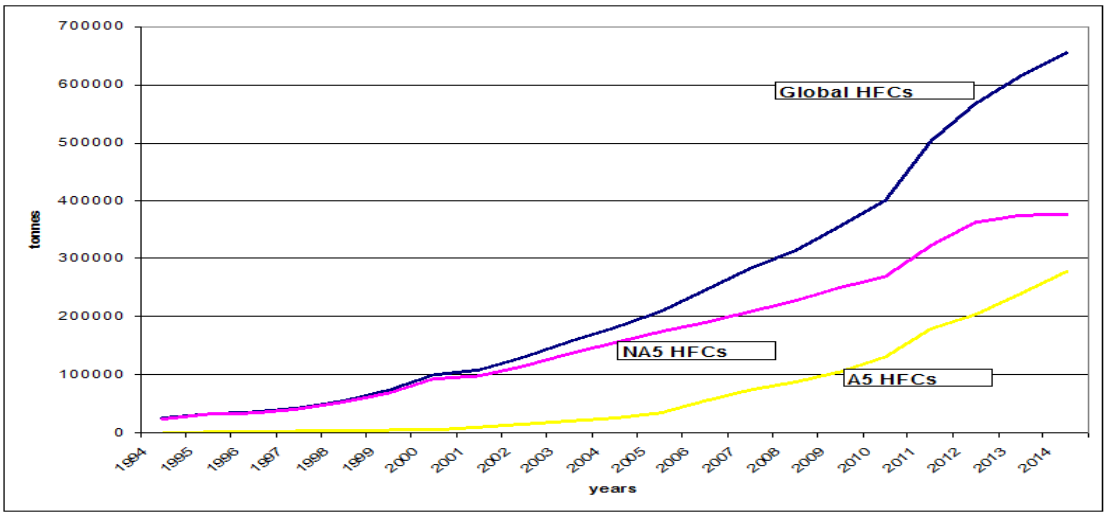
[14] Kazil *et al* recently published their results on the formation of TFA from HFO-1234yf. (See "Deposition and rainwater concentrations of trifluoroacetic acid in the United States from the use of HFO-1234yf", J. Geophys. Res. Atmos. (2014).) They show that the amount of TFA deposited over the continental United States is about the same as that estimated previously by D. Luecken and others (see "Ozone and TFA Impacts in North America from Degradation of (HFO-1234yf) - A Potential Greenhouse Gas Replacement*"*, Environ.Sci.Technol., 44(1), 343-348, doi:10.1021/es902481f (2010))**,** even though Kazil *et al* used a larger volume of emissions. This study shows that a larger fraction of the emitted HFO-1234yf and other similar relatively short-lived chemicals) escapes the region where they are emitted compared to earlier estimates by Luecken *et al* and Henne *et al* (Henne and others, "Future emissions and atmospheric fate of HFC-1234yf from mobile air conditioners in Europe", Env. Sci. Tech., 46(3), 1650–1658 (2012)). Emissions in the United States and Europe are not expected to increase significantly beyond current levels. Yet the assessment report and the recent study suggest that further investigations in regions of rapid growth may be warranted.

present note. As in the case of reported HFC emissions, for most countries data on production and consumption reveal large increases in recent years compared to base-year levels.

34. On the basis of the production and consumption data reported under the Framework Convention on Climate Change, it would appear possible to estimate **regional levels** of consumption and production in regions that include many Annex I parties. The Secretariat has not undertaken such an analysis.

35. At the **global** level, the Technology and Economic Assessment Panel has estimated through a bottom-up approach the demand (consumption) for HFCs (excluding HFC-23) for the period 1995–2014, disaggregated into totals for Article 5 and non-Article 5 parties.[15] The resulting trends, shown in figure 3, reveal that demand for HFCs started in the 1990s in developed countries and in around 2005 in developing countries, with a steep increase from 2005 to 2014. Global HFC demand for 2014 has been estimated at some 700,000 tonnes. Demand for HFCs grew by 10–12 per cent per year in non-Article 5 parties over the period 2001–2011, and thereafter growth was estimated to have decreased to 1–3 per cent per year from 2012 to 2014. In Article 5 parties demand for HFCs grew by up to about 32 per cent per year over the period 2006–2011, dropping to an estimated growth of less than 20 per cent per year thereafter.

Figure 3
Global demand for HFCs (in tonnes)

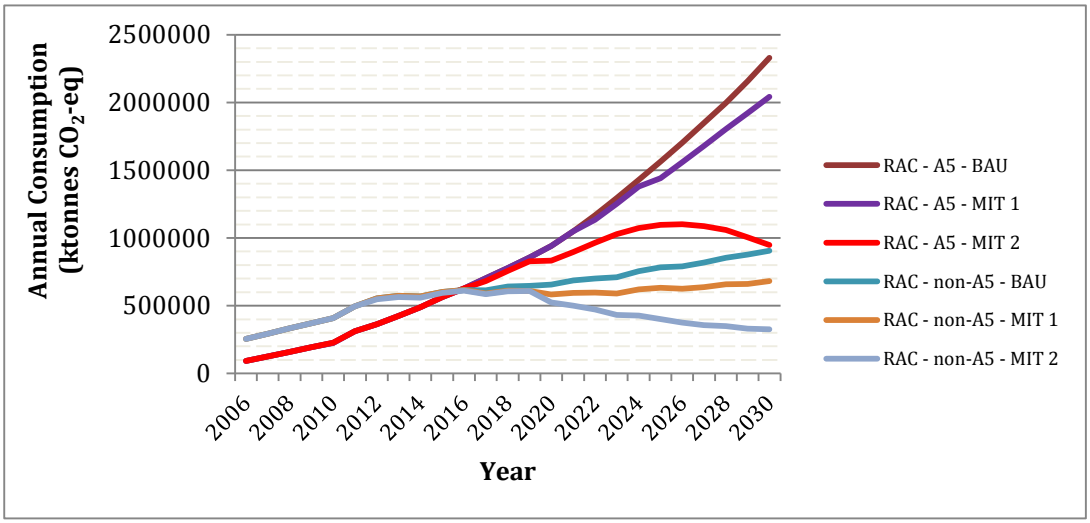


36. With regard to **future trends**, the Technology and Economic Assessment Panel has estimated consumption (potential emissions) trends in climate terms (CO_2-equivalent) up to 2030 in Article 5 parties and non-Article 5 parties on the basis of a "business as usual" (BAU) scenario and two mitigation scenarios for the refrigeration and air-conditioning sector and the foam sector, respectively**.** One mitigation scenario (MIT-1), believed to be relatively easily achievable, is based on current technology options and potential trends. The other mitigation scenario (MIT-2) is a more progressive assessment believed to be at the limit of what could be achieved in the period up to 2030. A comparison between BAU scenarios for the foam and RAC sectors shows that the contribution of the foam sector in determining global trends is rather insignificant. Focusing therefore on the RAC sector, figure 4 displays the BAU and mitigation scenarios in Article 5 and non-Article 5 parties for the period 2005–2030.

[15] conf.montreal-protocol.org/meeting/workshops/presentations-opening/Presentations/0-Kuijpers_opening%20session.ppt.

Figure 4

Business as usual and mitigation scenarios for HFC use in RAC in Article 5 parties and non-Article 5 parties during the period 2005–2030 (Climate impact, in kilotonnes CO_2-equivalent)



37. According to the Panel, the BAU scenarios for Article 5 and non-Article 5 parties do not take into account any policies or measures on the conversion to low-GWP alternatives in countries other than European Union member States. They can therefore be defined as unconstrained growth using economic growth parameters for the various Article 5 and non-Article 5 parties other than the European Union member States. The scenarios build upon trends from 2010 to 2015 in the size of refrigerant banks in the various refrigeration and air-conditioning subsectors.

38. The mitigation scenarios include assumptions regarding the introduction of low-GWP replacements in the RAC sector separately for Article 5 and non-Article 5 parties. While for Article 5 parties the scenarios are based on various dates for the prohibition of the use of certain high-GWP alternatives to ozone-depleting substances in new manufacturing, for non-Article 5 parties the scenarios are based both on varied dates and regulatory stimulus measures.

39. The percentage increases in total refrigerant demand (expressed in tonnes and CO_2-equivalent) during the period 2015–2030 for the BAU and mitigation scenarios for Article 5 and non-Article 5 parties are outlined in table 2.

Table 2

Percentage increase in total refrigerant demand during the period 2015–2030 under the scenarios developed by the Technology and Economic Assessment Panel

	Non-Article 5 parties		Article 5 parties	
Scenario	***Tonnes***	***Metric tonnes CO_2-equivalent***	***Tonnes***	***Metric tonnes CO_2-equivalent***
BAU	50%	38%	400%	400%
Mitigation-1	50%	14%	400%	365%
Mitigation-2	50%	-50%*	400% (2015–2025) 45% (2025–2030)**	200% (2015–2025) -15% (2025–2030)**

* Minus denotes a decrease in total refrigerant demand.

** Decrease compared to 2025 level.

40. Table 2 shows that while the future total refrigerant demand in tonnes increases by the same percentage under all three scenarios for each party group (50 per cent increase in non-Article 5 parties and 400 per cent increase in Article 5 parties), when the demand is expressed in CO_2 equivalent smaller increases or even decreases in total refrigerant demand are expected for future years. This is due to the decrease in the contribution of high-GWP refrigerants as they are gradually replaced by lower-GWP alternatives. In developing countries smaller increases and even decreases in future trends

are attributed to the decrease in the contribution of R-404A[16] (with a GWP of around 3,900) in favour of R-407A/C/F [17](with a GWP of around 1900) to the refrigerant total. In developed countries, much smaller increases or large decreases in future trends are attributed to the decrease in the contributions of R-404A, R-410A[18] and HFC-134a as well as the phase-out of high-GWP refrigerant in mobile air-conditioning (MAC) applications.

41. In terms of cumulative climate savings by 2030, the Technology and Economic Assessment Panel has estimated them to be approximately 3.8 billion tonnes CO_2-equivalent under MIT-1 and on the order of 12 billion tonnes CO_2-equivalent under MIT-2.

V. Regulatory frameworks, policy measures and initiatives to control HFCs

42. Many parties to the Montreal Protocol have put in place policies and measures to manage HFCs. These relate to a wide range of options including regulatory measures to control production, consumption and emissions of HFCs, economic incentives (taxation, subsidies, emissions trading) and other initiatives such as measures to improve energy efficiency, voluntary agreements, adoption of alternative technologies and awareness-raising activities. Several Article 5 parties are developing and implementing such measures in conjunction with their HCFC phase-out management plans. A number of initiatives that have taken at the corporate level have also been reported by a few parties.

43. At the Twenty-Sixth Meeting of the Parties the Secretariat presented a summary of available policy measures and initiatives based on voluntary submissions received from a number of parties in response to paragraph 3 of decision XXV/5.[19] Those submissions primarily describe measures at the national and regional levels. At the global level HFCs are under the purview of the United Nations Framework Convention on Climate Change. Section A, below, outlines the national and regional policy measures and initiatives reported by a number of parties. Section B presents a brief discussion of the global control measures established under the Framework Convention on Climate Change.

A. National and regional policy measures and initiatives reported by parties

44. Information on measures that promote a transition from ozone-depleting substances that minimizes environmental impact has been reported to the Secretariat by 23 parties, including the European Union, which reported on a number of regulatory measures applicable to its 28 member States and more specific information on behalf of five member States. In addition, the United States of America, through a study conducted by the United States Environmental Protection Agency (USEPA), provided additional information pertaining to a number of parties and the state of California.[20] The national and regional measures that have been reported by parties to date are listed in table 3 and are briefly discussed in the following paragraphs.

1. Regulatory frameworks

45. According to the parties' submissions mentioned above, 10 non-Article 5 parties including the European Union have reported having in place regulatory frameworks to control HFCs. Employed measures may vary from country to country but tend to include one or a combination of the following options:

(a) Control of the import, export, manufacture and end-use of HFCs and HFC-based equipment;

(b) Restrictions or bans on certain HFC uses;

(c) Prohibition of releases (including leakages) from specified sources during maintenance, service, repair, reuse, recycling, reclaiming, storage and disposal;

(d) Phase-down of HFC emissions;

[16] R-404A is a refrigerant mixture comprising HFC-134a, HFC-125 and HFC-143a.

[17] R-407 A, C and F are refrigerant mixtures comprising HFC-134a, HFC-125 and HFC-32 in slightly different proportions.

[18] R-410A is a refrigerant mixture comprising HFC-125 and HFC-32.

[19] UNEP/OzL.Pro.26/9.

[20] The original submissions by the parties can be found in documents UNEP/OzL.Pro.WG.1/34/INF/4; UNEP/OzL.Pro.WG.1/34/INF/4/Add.1; UNEP/OzL.Pro.WG.1/34/INF/4/Add.2; UNEP/OzL.Pro.26/INF/4; and UNEP/OzL.Pro.WG.1/35/INF/2.

(e) Requirements for binding annual national emission targets that may include HFCs;

(f) Establishment of codes of good practice in dealing with HFCs;

(g) Required practices such as HFC leakage checks, recovery and destruction, as well as training and certification of persons handling HFCs and HFC-based equipment, recordkeeping, reporting and labelling;

(h) Requirements for eco-design and energy labelling of equipment;

(i) Industry-based stewardship programmes to ensure the environmentally sound management and disposal of unwanted refrigerants;

(j) Incentives for the use of climate-friendly alternatives, improving systems design, maximizing energy efficiency and minimizing refrigerant leakage;

(k) Support for research and development of alternative technology.

46. At the regional level the regulatory measures of the European Union to curb HFCs are of particular importance. The party provided information on seven mandatory measures pertaining to HFCs, including its 2014 Fluorinated gas (F-gas) regulation, which provides for the phase-down of HFCs by 79 per cent by 2030 compared with 2014 levels; the MAC Directive, restricting HFC use to substances with a GWP no higher than 150; the directive on Waste Electrical and Electronic Equipment (WEEE), providing for separate collection and take-back systems for HFC-containing equipment and the return of waste to final holders and distributors free of charge; and the European Eco-Management and Audit Scheme, which promotes continuous improvement in the environmental performance of organizations through the establishment and implementation of environmental management systems, including with regard to HFC emissions and waste.

2. Economic incentives

47. Several parties reported on economic incentives that they provide to discourage the use of HFCs and other high-GWP substances. These incentives can be negative, as in the case of taxes and fees; or positive, as in the case of refunds and subsidies. They can also refer to other financial mechanisms such as emissions trading systems and compliance credits. Sometimes a negative incentive is matched with a positive incentive, which may further contribute to discouraging HFC use.

3. Other initiatives

48. Several parties have highlighted actions they have undertaken to promote energy-efficient solutions while moving away from ozone-depleting substances. Examples include:

(a) Developing and adopting ways to optimize energy management and reduce greenhouse-gas emissions from buildings;

(b) Engaging technical and scientific experts in the development, implementation and evaluation of programmes aimed at supporting measures to improve energy efficiency and low-GWP technologies in various industrial and commercial installations;

(c) Providing subsidies for introducing energy-saving equipment with natural refrigerants;

(d) Funding feasibility studies and demonstration projects for HFC-free and energy efficient alternatives to ozone-depleting substances in all relevant sectors;

(e) Establishing energy efficiency standards for appliances and buildings;

(f) Developing and implementing strategies for promoting the replacement of HFC-based technologies (e.g., refrigerators) in domestic markets with HFC-alternative-based energy-efficient technologies.

Table 3
Summary of reported policy measures to promote a transition from ozone-depleting substances to climate-friendly alternatives

Policy measures and initiatives	Parties*
Legislation, regulation & other mandatory measures	
Control of HFC production and consumption	Australia, Canada, Denmark, European Union,** Japan, Switzerland, United States *Austria, Belize, Colombia, Croatia, Montenegro, Serbia, Sweden, the Former Yugoslav Republic of Macedonia, Turkey*
Control of HFC emissions	Australia, Canada, European Union, Japan, Netherlands, Norway, Switzerland, Togo, United States *Colombia, Germany, Montenegro, New Zealand, Sweden, Yemen*
Training and certification	Australia, Canada, European Union, Japan, Netherlands, Norway, Republic of Moldova, United States *Italy, Montenegro, United Kingdom*
Record keeping and reporting	Australia, Canada, European Union, Japan, Netherlands, Norway, Switzerland, Togo, United States *Belize, Egypt, Montenegro, New Zealand*
Labelling	European Union, Norway, United States *Belize, Montenegro, Yemen*
Economic incentives	
Negative incentives	Denmark, Norway, Poland, Slovenia, Spain *Burkina Faso, China, New Zealand, the Former Yugoslav Republic of Macedonia*
Refunds and positive incentives	Belgium, Canada, Denmark, European Union, Germany, Japan, Mozambique, Norway, Spain, United States *Colombia, New Zealand*
Emission trading and compliance credits	European Union, United States *China, New Zealand*
HCFC phase-out management plans	
Introduction of alternatives to HFCs through projects funded by the Multilateral Fund	Bangladesh, El Salvador, Mexico, Paraguay, Republic of Moldova, Swaziland, Zimbabwe *Bosnia and Herzegovina, Maldives, Thailand*
Other initiatives	
Energy efficiency	Bangladesh, Canada, European Union, Japan, Mexico, Netherlands, Norway, United States *Sweden*
Voluntary agreements	Canada, European Union, Netherlands, United States
Industry initiatives	United States
Alternative technologies	Canada, Denmark, Germany *Brazil, India, Mauritius*
Awareness raising	Denmark, European Union**, Ireland, Netherlands, Norway, United States

* Parties in italics have not submitted information to the Secretariat themselves; information presented in the table has been taken from the USEPA report submitted by the United States.

** The European Union submitted regulations applicable to its 28 member States and additional information on behalf of five member States (Denmark, Ireland, Poland, Slovenia and Spain). All European Union member States that have submitted information either through the European Union or individually are listed in the table.

4. Voluntary agreements

49. Some of the initiatives mentioned above are based on voluntary agreements that Governments have made with other entities including international organizations, non-governmental organizations, the private sector and other parties. In addition, a few parties reported on efforts to promote voluntary agreements with end users (e.g., green deals in the Netherlands) and partnership programmes uniting stakeholders within an industry and providing a forum for collaboration on HFC emissions reductions (e.g., the GreenChill Advanced Refrigeration Partnership and the Responsible Appliance Disposal (RAD) programme in the United States).

50. At the international level, a major voluntary agreement is the Climate and Clean Air Coalition to Reduce Short-lived Climate Pollutants, including HFCs. The Coalition was launched in February 2012 by the Governments of Bangladesh, Canada, Ghana, Mexico, Sweden and the United States along with UNEP. It currently consists of 99 partners, with 45 country partners and 54 non-state

partners. Recognizing that mitigation of the impacts of short-lived climate pollutants is critical in the near term for addressing climate change and that there are many cost-effective options available, the Coalition aims to catalyse rapid reductions in short-lived climate pollutants in order to improve public health, food and energy security and climate. With a focus on methane, black carbon, tropospheric ozone and HFCs, the Coalition has undertaken several initiatives to date, including one on promoting HFC alternative technology and standards.

51. Under the HFC initiative, Coalition partners are currently supporting the development of HFC inventories and studies, information exchange on policy and technical issues, demonstration projects to validate and promote climate-friendly alternatives and technologies and various capacity-building activities to disseminate information on emerging technologies and practices in order to move away from high-GWP HFCs and minimize HFC leakage.

52. In 2014 the HFC initiative's undertakings included the completion of national inventories in Bangladesh, Chile, Colombia and Indonesia (including disaggregated HFC consumption data for the period 2008–2012 and projections up to 2020), with inventories for Ghana and Nigeria nearing completion; five case studies demonstrating feasible technologies, cost savings and efficiency gains in the commercial refrigeration sector; and 10,000 hours of training benefitting over 900 participants. More HFC surveys are to start in a number of countries (Bahamas, Cambodia, Jordan, Kyrgyzstan, Maldives, Mongolia, South Africa, Viet Nam). In addition, the Coalition reported that a feasibility study for district cooling in the Maldives was under way and that a knowledge platform (HFC-Ville) was under construction to provide information on HFC consumption and alternatives online.

5. Corporate initiatives

53. Several corporations are integrating HFC initiatives into their sustainability strategies. Companies are not only recognizing the potential climate impact of HFCs but are responding proactively to anticipated future HFC regulations and increasing customer concern. Many corporate initiatives on low-GWP alternative substances and technologies, voluntary reduction targets and research projects have emerged. The beverage industry (including companies such as Coca-Cola, Pepsi and Red Bull) in particular is an example of private enterprises driving the transition to non-HFC refrigerant alternatives.

54. In addition to initiatives by individual companies, there are industry programmes that bring together corporations from around the world. The primary purpose of these initiatives is the mobilization of businesses through knowledge sharing and support. Two examples of these industry initiatives are Refrigerants, Naturally! and the Consumer Goods Forum.

B. Global policy framework: the United Nations Framework Convention on Climate Change

55. At the global level HFCs fall under the purview of the United Nations Framework Convention on Climate Change and its Kyoto Protocol. The Convention, which was adopted in 1992 and entered into force in 1994, currently has 196 Parties. Its ultimate objective is to *"stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"*. Based on a set of principles including "common but differentiated responsibilities" and "respective capabilities", the precautionary approach and cost-effectiveness, the Convention provided the framework for negotiating its Kyoto Protocol, which sets internationally binding emissions limits and reduction objectives for greenhouse gases for industrialized countries, also known as emission reduction targets.

56. The Kyoto Protocol, which was adopted in 1997 and entered into force in 2005, shares with the Convention the objective of stabilizing the concentration of greenhouse gas emissions in the atmosphere at levels that would prevent dangerous interference with the climate system in line with the principles of the Convention. In its first five-year commitment period, 2008–2012, ratified by 192 Parties, the Protocol set legally binding emissions reduction targets for 37 industrialized countries and the European Union. Overall, those targets were expected to lead to a reduction in the overall emissions of industrialized countries for the first commitment period of at least five per cent on average of 1990 emissions levels.

57. A second commitment period, launched through the adoption of the Doha Amendment to the Kyoto Protocol in December 2012, requires industrialized country Parties to reduce greenhouse gas emissions by at least 18 per cent below 1990 levels in the eight-year period from 2013 to 2020. The second commitment period, in which the composition of Parties that assumed emissions reduction commitments is different from the first, has not yet entered into force.

58. States parties to the Framework Convention on Climate Change are currently negotiating the elements of a protocol, other legal instrument or agreed outcome with legal force under the Convention in accordance with the mandate enshrined in decision 1/CP.17, adopted by the Conference of the Parties to the Convention in Durban, South Africa, in 2011. The protocol, instrument or outcome, if adopted, would be applicable to all Parties. Negotiations are being held through a subsidiary body of the Conference of the Parties known as the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP), and are expected to be completed no later than 2015 so that the agreement can be adopted at the twenty-first session of the Conference of the Parties and come into effect starting in 2020.

59. In that context, at its nineteenth session, in Warsaw in November 2013, the Conference of the Parties adopted a decision that, inter alia, invited parties to initiate or intensify domestic preparations for their intended nationally determined contributions to achieving the objective of the Convention as set out in its Article 2 with the aim of reporting them to the secretariat by the first quarter of 2015. At its twentieth session (2014), the Conference of the Parties reiterated the decision and agreed that each party's intended nationally determined contribution would represent a progression beyond the current undertaking of the Party, i.e., would not permit "backtracking".

60. The targets set for the first commitment period covered the six greenhouse gases and groups of gases listed in Annex A to the Convention, namely, CO_2; methane (CH_4); nitrous oxide (N_2O); HFCs; PFCs; and sulphur hexafluoride (SF_6). (In the second commitment period an additional potent greenhouse gas, nitrogen trifluoride (NF_3), with a GWP of 17,200, would also be subject to emissions reductions). An emissions reduction target for the first commitment period, measured as a percentage of the aggregate anthropogenic base year CO_2-equivalent emissions of all six greenhouse gases in Annex I, reduced by the amount the gases removed by sinks, is inscribed in Annex B to the Kyoto Protocol for each Annex I party. Although the base year specified in the Protocol is 1990, for HFCs, PFCs and SF_6 parties may use 1995.[21] For the purpose of calculating carbon dioxide equivalent quantities, emissions must be multiplied by the relevant global warming potential accepted by the Intergovernmental Panel on Climate Change and agreed upon by the Conference of the Parties at its third session.

61. Because no individual emissions target is assigned to HFCs, each Party to the Protocol has the flexibility to decide on the substances whose emissions it will seek to reduce, as well as the sectors in which reductions are to be achieved. It can even choose to allow for an increase in the emissions of some greenhouse gases as long as its overall emissions target at the end of the commitment period is met. Since HFCs have to date been responsible for only minor contributions to total emissions compared to other greenhouse gases, they tend to be overlooked or not prioritized by parties in choosing which gases to reduce. As a result, emissions of HFCs are rising.

62. Indeed, according to a 2014 report[22] that compiled and synthesized data and information reported during the first commitment period in the national communications of Annex I parties to the Convention that are also Parties to the Kyoto Protocol, emissions of each of the greenhouse gases in Annex I except HFCs declined during the period 1990–2012. While total emissions of PFCs declined by as much as 79 per cent, followed by SF_6 by 62.2 per cent, N_2O by 25.3 per cent, CH_4 by 19.6 per cent and CO_2 by 8.7 per cent, emissions of HFCs increased by 175.8 per cent over the same period, "owing mainly to the increased use of HFCs as a substitute for ozone-depleting substances controlled by the Montreal Protocol".[23] The report also notes that HFC emissions in Annex I parties, which in 1990 accounted for 0.6 per cent of total greenhouse gas emissions, in 2012 accounted for approximately 1.7 per cent of the total.

63. Under the Convention and its Kyoto Protocol there are a number of institutions, mechanisms and arrangements aimed at facilitating implementation. Three of these of particular relevance to the management of HFCs, namely, reporting and review arrangements, the Technology Mechanism and the Financial Mechanism, are briefly described in the following paragraphs.

[21] Parties with economies in transition may elect a year other than 1990 as a base year.

[22] Compilation and synthesis of sixth national communications and first biennial reports from Parties included in Annex I to the Convention (FCCC/SBI/2014/INF.20).

[23] Through the phase-out of ozone-depleting substances that are also potent greenhouse gases, the Montreal Protocol has, however, already averted greenhouse gas emissions equivalent to more than 135 billion tonnes of carbon dioxide. These significant reductions make the Protocol one of the prime contributors to the fight against global warming.

1. Reporting and review of HFC emissions and related information

64. All Parties to the Convention are committed to developing and periodically submitting special reports called national communications. A Party's national communication must contain information on its greenhouse gas emissions and describe the steps it has taken and plans to take to implement the Convention.

65. In 2010, at its sixteenth session, the Conference of the Parties decided that Annex I parties should also submit biennial reports on their progress in achieving emissions reductions, including information on mitigation actions to achieve their quantified economy-wide emissions targets and emissions reductions achieved, projected emissions and the provision of financial, technology and capacity-building support to developing country parties. The Conference of the Parties also decided that non-Annex I parties should submit biennial update reports. In 2011, at its seventeenth session, the Conference of the Parties adopted biennial reporting guidelines for Annex I parties and non-Annex I parties,[24] with submission deadlines for the first biennial reports being 1 January 2014 and for biennial update reports three years after the provision of support for their preparation.

66. The different reporting requirements for Annex I parties and non-Annex I parties are summarized in the following paragraphs.

67. Annex I parties (developed countries and countries with economies in transition) submit their national communications periodically (under decision 2/CP.17 the period for submission was set at four years). They are also required to submit their national greenhouse gas inventories annually in accordance with guidelines adopted by the Conference of the Parties and methodologies developed by IPCC. Reporting on national greenhouse gas emissions requires the completion of a series of tables in an established common reporting format (CRF) accompanied by national inventory reports that contain information on data and trends as well as a description of the methodologies applied to derive the reported data. These inventories are reviewed annually by expert review teams to determine their completeness, accuracy, consistency, comparability and transparency. Likewise, the national communications and biennial reports are reviewed by expert review teams upon their submission. They are also subject to multilateral assessment as part of the international assessment and review process for Annex I parties.

68. Non-Annex I parties (developing countries) are required to submit their national communications according to a differentiated timetable and subject to the prompt provision of financial resources to cover the agreed full costs incurred by them in preparing their reports. Developing country parties should also submit, consistent with their capabilities and the level of support provided for reporting, biennial update reports containing updates of national greenhouse gas inventories, including a national inventory report and information on mitigation actions, needs and support received. Least developed countries and small-island developing States may submit biennial update reports at their own discretion. The biennial update reports of developing country Parties are subject to an international consultation and analysis process, aiming to increase the transparency of mitigation actions and their effects through analysis by technical experts in consultation with the Party concerned and through a facilitative sharing of views.

69. As noted earlier, given the reporting requirements of Annex I parties and the review procedure involved, there exists reliable national information on HFC emissions by such parties. HFC data for these Parties, disaggregated into HFC components, appear in the CRF system under the industrial processes section and are available through the Convention database. [25] Such information is also available for some non-Annex I parties through their national communications reports under the Convention.[26]

2. Technology Mechanism

70. The Technology Mechanism of the Convention was established by the Conference of the Parties at its sixteenth session, in 2010, with the objective of enhancing action on the development and transfer of technology to support action on mitigation and adaptation in order to achieve the full implementation of the Convention. It consists of the Technology Executive Committee and the Climate Technology Centre and Network.

[24] See decision 2/CP.17 of 2011, annexes I and III (FCCC/CP/2011/9/Add.1).

[25] http://unfccc.int/ghg_data/ghg_data_unfccc/time_series_annex_i/items/3814.php.

[26] http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php.

71. The Technology Executive Committee is the policy component of the Technology Mechanism, providing the Conference of the Parties with recommendations on matters related to the development and transfer of technology. The Climate Technology Centre and Network is the implementation component of the Technology Mechanism. Its primary mission is to respond to developing countries' requests submitted through their national designated entities with a view to facilitating the preparation and implementation of technology projects and strategies. In doing so, the Centre and Network assists developing countries consistent with their respective capabilities and national circumstances and priorities and strengthens their capacity to identify technology needs. The network consists of a Climate Technology Centre based in Copenhagen and a network of institutions around the globe capable of responding to requests from developing countries related to climate technology development and transfer.

72. According to information provided by the Climate Technology Centre, with regard to HFCs the Centre has thus far received, and declared eligible under the Centre and Network's mandate, a joint request from four African countries (Ghana, Kenya, Mauritius and Namibia) for support for those countries' participation in the Green Cooling Africa Initiative with a view to mitigating greenhouse gas emissions from RAC appliances both through improved energy efficiency and the reduction of leakage of high-GWP refrigerants. The outputs envisaged are a compilation of robust greenhouse gas inventories, analysis of the technological gap between business as usual and internationally available best technological options, recommendations for a policy and regulatory framework and recommendations for a regional and country-specific technology roadmap. The project suggests that each participating country be supported with a budget of $200,000 for various activities. Implementation is expected to start in 2015.

73. According to the Climate Technology Centre, there are indications that additional HFC-related requests may be submitted seeking support for the replacement of fluorocarbon-based refrigerants in refrigeration systems in food processing production and exports (fruits and vegetables) in Chile and the replacement of fluorinated refrigerants for end users of refrigeration equipment in the dairy sector in Uruguay.

3. Financial Mechanism

74. Under the **Financial Mechanism** of the Convention, projects related to HFC mitigation in developing countries and countries with economies in transition have been financed primarily through the Global Environment Facility (GEF). In addition, two of the three so-called "flexibility mechanisms" of the Kyoto Protocol, namely, the Clean Development mechanism and Joint Implementation (the third being International Emissions Trading) provide means of reducing greenhouse gas emissions at low cost. Possibilities for funding also exist under the recently established Green Climate Fund, which has an initial capitalization of more than $10 billion but has not yet been operationalized.

75. Since its inception in 1991 GEF has financed a wide range of climate change projects. By 2014 total funding for mitigation actions was reported to amount to $4.5 billion.[27] According to GEF, total GEF funding for HFC-related projects amounts to $102,572,582 for 19 projects primarily on energy efficiency in the air-conditioning sector. These projects also received host country co-financing of $489,952,902. Two of those projects, with GEF funding of $10,950,000 and co-financing of $29,395,000, have dealt specifically with a transition to low-GWP HFCs.

76. The **Clean Development Mechanism** aims to assist non-Annex I parties in achieving sustainable development and in contributing to the ultimate objective of the Convention while at the same time assisting Annex I parties in achieving compliance with their emissions targets under the Kyoto Protocol. The Mechanism allows Annex I parties with emissions reduction or emissions limitation commitments under the Kyoto Protocol to finance emissions reduction projects in developing countries. Such projects can earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, which the Annex I party can use to meet its reduction or limitation commitments.

77. To date, over 7,500 projects have been registered and almost 1.5 billion CERs have been issued under the Mechanism. According to the Convention secretariat, 23 projects financed through the Mechanism involve the destruction of HFC-23 and HFC-134. Four of these projects have declared investments totalling approximately $18 million. Assuming similar projects in the same country are

[27] "Report of the Global Environment Facility to the Conference of the Parties (FCCC/CP/2014/2).

equally costly, all 23 projects sum up to a total investment in HFC mitigation technology enabled by the Mechanism of approximately $140 million.

78. Out of the above-mentioned 23 projects, 19[28] have resulted in the destruction of an average of about 300 tonnes of HFC-23 per year.[29] By the end of 2014 those projects had resulted in the destruction of approximately 35,000 tonnes of HFC-23, with an associated emissions reduction of over 500 million tonnes of CO_2 equivalent.[30]

79. According to the current eligibility criteria under the Clean Development Mechanism, for an HFC-23 project to be registered under the mechanism the corresponding HCFC-22 facilities must have operated for at least three years between 2000 and 2004. The amount of HCFC-22 production that is eligible for crediting is limited to the maximum historical HCFC-22 production in the last three years of operation within the period 2000–2004. These safeguards have been put in place to address possible perverse incentives to establish new HCFC-22 production plants or to increase HCFC-22 production or HFC-23 generation in existing plants in order to attract financing through the Mechanism. HFC-23 projects under the Mechanism have very good performance records, usually eliminating more than 99.99 per cent of emissions. In industrialized countries, most plants have installed HFC-23 incinerators over the past two decades. The average emission rate from all plants in Annex I countries, however, still amounted to about 0.4 per cent in 2011, considerably higher than that of plants in developing countries benefitting from projects financed through the Clean Development Mechanism.

80. In a similar vein, **Joint Implementation** offers parties a flexible and cost-efficient means of fulfilling a part of their Kyoto commitments while promoting foreign investment and technology transfer. This is achieved by allowing a party with an emissions reduction or limitation commitment under the Kyoto Protocol to earn emission reduction units (ERUs) by financing an emission reduction or emission removal project in another party with corresponding obligations. The investing party can count the ERUs it earns, each equivalent to one tonne of CO_2, towards its reduction or limitation target, while the host party benefits from the investment and technology transfer required for the project.

81. To date, almost 700 projects have been approved and over 800 million ERUs under the Joint Implementation mechanism. Of these projects, three have directly involved the destruction of HFCs. Although the amount of investment in HFC abatement technology under these projects is not publically available, by the end of 2012 they had resulted in the abatement of 4.5 million tonnes of CO_2 equivalent, or about 306 tonnes of HFCs, approximately 50 per cent of the potential of the projects.

82. Recent studies have shown that the cost of abating HFC-23 using the flexibilty mechanisms is very low, on the order of approximately 0.07 euro cents per tonne of CO_2 equivalent. Nevertheless, as a result of the drop in demand for, and price of, CERs and ERUs since mid-2012, the abatement achieved under these projects has slowed and, in the absence of legislation to prevent it, is at risk of ceasing altogether. This is because the projects generate little or no revenue other than CERs or ERUs, in the absence of which there is no money to fund the continued destruction of HFCs.

VI. Discussions on proposed approaches to controlling HFCs under the Montreal Protocol

83. Since 2009 two proposals to amend the Montreal Protocol for phasing down the production and consumption of HFCs have been put forward for the parties' consideration. The first proposal was put forward in 2009 by the Federated States of Micronesia, originally co-sponsored by Mauritius and in subsequent years by a few other parties (hereinafter referred to as the Federated States of Micronesia proposal). The second proposal was put forward in 2010 jointly by Canada, Mexico and the United States (hereinafter referred to as the North American proposal). These proposals, with minor modifications, have been presented at all subsequent meetings of the parties. In addition, in November 2014 the European Union presented a discussion paper to the Twenty-Sixth Meeting of the Parties in which it shared its views on an alternative approach that could form the basis of an

[28] Eleven of these projects were in China, nine in India, one in Argentina, one in Mexico and one in the Republic of Korea.

[29] This figure was provided by the Framework Convention on Climate Change secretariat, which clarified that it based its estimate on a GWP of 14,800 for HFC-23 for the second commitment period of the Kyoto Protocol.

[30] The figure is equal to 84 per cent of the registered mitigation potential of these projects.

amendment to the Protocol. The amendment proposals and the European Union paper share the following ideas:

(a) There is ample scientific evidence that although HFCs currently constitute a small portion of greenhouse gas emissions their abundance in the atmosphere is rapidly increasing, mostly due to increased demand for refrigeration and air-conditioning, particularly in developing countries, and because they are replacing ozone-depleting substances. If HFC use and emissions are left unaddressed, they will have a significant impact on radiative forcing of the Earth's climate;

(b) Controlling HFCs under the Montreal Protocol poses no legal obstacles to the undertakings of the Framework Convention on Climate Change on HFCs but rather supports, complements and enhances its role by achieving significant mitigation benefits;

(c) In line with the Montreal Protocol's principle of common but differentiated responsibilities, actions to control HFCs would be undertaken first by developed country parties, while developing county parties would have a longer period to meet their obligations;

(d) There has been progress in the development of alternatives to HFCs that are technically and economically feasible and demonstrate improved energy efficiency. Such alternatives are not yet available for every application;

(e) Several parties have undertaken a range of policy measures to control HFCs at the national and regional levels, including the adoption of regulations, the provision of economic incentives and participation in voluntary international agreements. A global approach, however, is needed to send a clear signal to industry (the private sector and markets) to spur it to intensify the development of low-GWP alternatives;

(f) Financial support for developing countries for the control of HFCs under the Protocol would be provided by the Multilateral Fund according to its established procedures, covering all agreed incremental cost of Article 5 party compliance with their HFC targets in the context of the replenishment triennia and technical assistance.

84. The key elements of the two amendment proposals and the discussion paper are outlined in sections A and B below, respectively, in the chronological order in which they were put forward for the parties' consideration. A schematic presentation is given in tables 4, 5 and 6.

A. Proposed amendments for the control of HFCs under the Protocol

85. Since they were first put forward, the Federated States of Micronesia proposal and the North American proposal have been presented, with minor changes, at all subsequent meetings of the parties. The summary presented in the following paragraphs refers to the versions of the two proposals presented at the Twenty-Sixth Meeting of the Parties in November 2014.[31]

1. Federated States of Micronesia proposal

86. The Federated States of Micronesia proposal aims at phasing down the consumption and production of 21 HFCs with GWPs ranging from 4 to 9,810. For non-Article 5 parties the proposed consumption and production baselines are based on average levels of HFC and HCFC consumption and production over 2014–2016, and the proposed phase-down schedule would begin in 2017 with 85 per cent of the baseline levels, dropping to 10 per cent by 2035. For Article 5 parties, the phase-down would begin a number of years later, on an equitable schedule to be negotiated by the parties.

87. The proposal also includes provisions for limiting by-product emissions of HFC-23 beginning in 2017; banning non-party imports and exports of HFCs and products containing HFCs; determining the feasibility of banning or restricting imports from non-parties of products produced with but not containing HFCs; establishing and implementing a system for licensing the import and export of new, used, recycled and reclaimed controlled HFCs and allowing Article 5 parties to delay compliance with this provision for a specific period of time; annual reporting of HFC consumption and production and by-product emissions; the transfer of consumption rights between non-Article 5 parties; a production allowance to non-Article 5 parties to satisfy the basic domestic needs of Article 5 parties; and funding for Article 5 parties through the Multilateral Fund unless any part of agreed incremental costs is funded from any other financial mechanism. The proposal also provides that Article 5 parties choosing

[31] UNEP/OzL.Pro.26/5 and UNEP/OzL.Pro.26/6.

to begin implementation of the HFC phase-down in advance of the schedule agreed to by the parties would be able to avail themselves of funding under the Protocol's financial mechanism.

88. According to its proponents, the amendment could prevent over 100 Gt of CO_2-equivalent emissions in the next several decades and could constrain global average temperature increase by up to 0.5º C by 2100. A faster strategy that would "leap frog" HFCs during the current HCFC phase-out could prevent emissions of up to an additional 64 Gt of CO_2-equivalent.

2. North American proposal

89. The proposal aims to phase down the consumption and production of 19 HFCs with GWPs ranging from 12 to 9,810 on a GWP-weighted basis. For non-Article 5 parties the amendment proposes consumption and production baselines based on specified percentages of average HFC and HCFC levels of consumption and production over 2008-2010 and a phase-down schedule starting at 90 per cent of baseline levels in 2018 and dropping to 15 per cent by 2035. For Article 5 parties, the proposed baselines are based on specified percentages of average HFC and HCFC levels of consumption and production over 2011–2012, while the phase-down would stretch from 100 per cent of the baseline levels in 2020 to 15 per cent in 2045.

90. The proposal also includes provisions for limiting by-product emissions of HFC-23; banning non-party HFC imports and exports; establishing and implementing a system for licensing the import and export of new, used, recycled and reclaimed controlled HFCs and allowing Article 5 parties to delay compliance with this provision; annual reporting of HFC consumption and production (excluding HFC-23) as well as HFC-23 by-product emissions and amounts captured and destroyed by technologies to be approved by the parties; the transfer of consumption rights between non-Article 5 parties; a production allowance to non-Article 5 parties to satisfy the basic domestic needs of Article 5 parties; and funding for Article 5 parties through the Multilateral Fund except when those parties avail themselves of funding from any other financial mechanism.

91. According to estimates by the Government of the United States, the cumulative environmental benefits of the proposed amendment are estimated at between 93.8 and 115 billion metric tonnes of CO_2 equivalent through 2050 and about 115.8 billion–141.1 billion metric tonnes CO_2 equivalent for 40 years after the effective date of the proposal as a result of the replacement of HFCs with low-GWP alternatives. Cumulative benefits from HFC-23 by-product emissions controls are estimated to amount to an additional 12.9 billion metric tonnes CO_2 equivalent through 2050 and about 15.7 billion metric tonnes CO_2 equivalent in the 40 years following the effective date of the proposal.

3. Summary of party views on the amendment proposals

92. The possibility of amending the Protocol to control the production and consumption of HFCs has been the subject of extensive discussions since the two amendment proposals were put forward in 2009 and 2010. Deliberations have since been held in an informal setting, assisted by further information and clarifications provided by experts, party representatives and representatives from relevant United Nations institutions and the private sector at the two workshops held in 2009 and 2014. Recognizing that a potential amendment to the Protocol would pose a number of legal, technical and financial challenges, parties have debated how such challenges could be addressed. The main views expressed by parties supporting and opposing an amendment to the Protocol dealing with HFCs are summarized in the following paragraphs.

Arguments in support of an amendment

93. Parties supporting the proposed amendments have argued that:

(a) HFCs have not been reduced under the Framework Convention on Climate Change because they are only one of a number of gases subject to the Convention. Parties to the Convention are free to decide which gases should be the subject of their emissions reduction efforts. Action taken under the Montreal Protocol has been contributing to the growth in HFC emissions, and parties have a clear responsibility to act to tackle HFCs by avoiding their adoption as alternatives to ozone-depleting substances;

(b) The reasons for including HFCs in the Montreal Protocol do not rest primarily on the success to date of the agreement, but on the fact that the Protocol is uniquely placed to tackle the issue given its experience in phasing out substances in exactly the same sectors in which HFC use is expanding;

(c) There is no reason why the Montreal Protocol cannot work together with the United Nations Framework Convention on Climate Change and the Kyoto Protocol thereto in tackling the control of HFCs. Matters related to emissions and accounting could continue to be covered by the

Framework Convention, while those related to consumption and production could be dealt with under the Montreal Protocol in partnership with the Framework Convention;

(d) It is not problematic to consider climate objectives under the Protocol; they are already routinely taken into account, for example in many decisions of the Executive Committee of the Multilateral Fund;

(e) The proposition that a particular class of substances could only be dealt with under one treaty is unjustified. There are many examples of treaties successfully working together on common problems, including HCFC use being addressed by the MARPOL Convention[32] and methyl bromide use being addressed by the International Plant Protection Convention. Including HFCs in the Montreal Protocol would in no way undermine the climate regime; rather, it would reinforce it, helping to phase out an estimated 96 billion tonnes of CO_2 equivalent by 2050, with a very significant positive impact on the climate;

(f) The Vienna Convention provides the scope for the Montreal Protocol to tackle HFCs, even though they are not ozone-depleting substances; Article 2 of the Vienna Convention allows the parties to coordinate their policies in managing the phase-out of HCFCs and the introduction of alternatives, including HFCs; action to reduce HFCs is therefore clearly appropriate under the Protocol;

(g) The proposed approaches respect the principle of common but differentiated responsibilities, as they foresee different schedules for the phase-down of HFCs for parties operating under paragraph 1 of Article 5 and those not so operating;

(h) Alternatives to HFCs with low global-warming potential do exist in many sectors and could feasibly be adopted, as shown by the reports of the Technology and Economic Assessment Panel. The Panel reports clearly show that alternatives currently in use or being developed would already allow significant reductions in HFC use by 2020;

(i) More information is currently available on alternatives to HFCs than was available on alternatives to CFCs or HCFCs when the phase-out of those substances was agreed upon. The parties have faced similar situations previously and the outcomes have always been positive;

(j) While the phase-out of HCFCs is still in its early stages and a number of countries have just submitted their HCFC phase-out management plans, timely action on HFCs is necessary to avert the additional costs that will accrue if action is delayed;

(k) The Multilateral Fund has sufficient funding only to support phase-out activities for substances currently controlled by the Protocol; if HFCs were added to the Protocol, the Multilateral Fund would clearly require significant additional resources;

(l) Although the Executive Committee agreed, in April 2010, to increase financing by 25 per cent for non-HFC alternatives, the problem posed by HFCs requires a more comprehensive approach that would provide an incentive for industry to develop HFC alternatives and would include funding for incremental costs;

(m) Under the terms of the Durban Platform of the Framework Convention on Climate Change a new climate treaty will not enter into force for several years; the parties cannot wait that long to take action on HFCs given the rapid increase in their production and consumption. The Montreal Protocol has established an efficient and effective regime that is well suited to controlling HFCs.

Arguments against an amendment

94. Parties opposing the proposed amendments have argued that:

(a) HFCs are not ozone-depleting substances and therefore come under the purview of the Framework Convention on Climate Change and its Kyoto Protocol; subjecting them to the Montreal Protocol is therefore inappropriate and could have counterproductive legal, political and technical consequences;

(b) Recent figures show that HFCs represent only 0.7 per cent of total emissions of greenhouse gases, suggesting that, while climate change is clearly a matter of concern, the current focus on HFCs is misplaced. Furthermore, the climate regime's approach of applying controls to a

[32] International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997.

basket of greenhouse gases is a flexible and convenient one, allowing parties to choose which gases they wish to limit;

(c) Article 2 of the Vienna Convention is not sufficient to allow the Montreal Protocol to take on HFCs. Furthermore, since HFCs do not deplete the ozone layer, the Vienna Convention is not relevant;

(d) The principles of common but differentiated responsibilities and respective capabilities are not reflected in the Montreal Protocol. It is clear that under the Framework Convention on Climate Change developed countries are responsible for mitigation and developing countries are encouraged to take action only under certain conditions, including the availability of financial assistance and technology transfer. To take on HFCs under the Montreal Protocol would represent an effective transfer of the burden of reducing HFCs from developed to developing countries;

(e) Alternatives to HFCs do not exist for all uses, in all regions or for all climatic conditions, especially for the most widely used HFCs, which are used in the air-conditioning and refrigeration sector; consultations with key stakeholders in several countries have revealed significant opposition to the proposed amendments and an inability to implement them in accordance with the proposed time frames;

(f) Until technically viable, cost-effective and safe alternatives become more widely available it is premature to discuss proposals to amend the Protocol. Discussions on the reports of the Technology and Economic Assessment Panel have highlighted the fact that alternatives to HFCs are only available at high cost, are often flammable or toxic and for many uses are not available at all, particularly for small and medium-sized enterprises;

(g) If HFCs are to be phased down, industry in Article 5 parties will become dependent on very expensive products produced by a small number of chemical manufacturers; given that alternative technologies are not readily available and the costs of conversion are high, there will be adverse impacts on both producers and consumers; the feasibility and impacts of introduced alternatives need to be properly evaluated in order to avoid adverse implications for the long-term stability of industry;

(h) Suitable technologies do not yet exist for use in high-ambient-temperature countries. Furthermore, recently adopted international standards on the use of flammable refrigerants limit the use of hydrocarbons to air-conditioning systems too small to be widely used in such countries;

(i) The argument that an amendment should be adopted in order to encourage industry to develop alternatives in the future is dangerous; economically and socially acceptable technology must be available before any additional commitments can be entered into;

(j) The task of phasing out HCFCs is already stretching the resources of many Article 5 parties. As HFCs are important alternatives to HCFCs in many developing countries, restricting them will impede the accelerated phase-out of HCFCs and could cripple their economic growth; taking on HFCs will divert time, attention and resources from the most important implementation priorities, including the phase-out of HCFCs and urgently needed measures to deal with banks of ozone-depleting substances;

(k) HFCs continue to be used by non-Article 5 parties, while their industries continue to sell HFCs to Article 5 parties. No transfer of alternative technology is occurring, and there is no clarity regarding the availability of financial support for phasing down HFC use in Article 5 parties;

(l) Given the financial difficulties noted by various donors, new obligations to phase out HFCs might not be accompanied by new and adequate financial and technical assistance;

(m) Even if it should prove legally and politically possible to tackle HFCs under the Montreal Protocol, doing so would require waiting for the conclusion of related discussions under the climate regime.

Other views expressed by parties

95. Some parties have expressed views that do not clearly support or oppose the amendment proposals but stress the importance of providing incentives for parties to adopt low-global-warming potential (low-GWP) alternatives to HCFCs; developing cost-effectiveness thresholds to ensure that more low-GWP alternatives are included in projects supported by the Multilateral Fund; providing adequate funding and technology transfer in developing and implementing alternatives as well as increased financial and technical support for pilot projects using low-GWP alternatives.

96. Some parties have argued that since it would inevitably take several years for any new amendment to the Montreal Protocol to be negotiated and ratified it might be better to focus on

providing financial assistance aimed at reducing HFC use immediately without establishing any new legal requirements. Another idea put forth is that parties concerned about HFCs could donate money and expertise to the Framework Convention and Kyoto Protocol to address the problem under those agreements.

97. Several parties expressed willingness to discuss the proposed approaches formally with a view to clarifying and resolving the issues raised, including the legal and technical implications of the proposed amendment for the relationship between the Montreal Protocol, the Framework Convention on Climate Change and the Kyoto Protocol; the environmental impact of HFCs; the impact of the proposed amendments on very-low-volume-consuming countries; the availability and cost of alternatives to high-GWP HFCs, including related safety and energy efficiency issues; the comparative cost and efficacy of HFCs versus those of the potential low-global-warming potential alternatives to HFCs; the market penetration of non-HFC alternatives to HCFCs in the air-conditioning and refrigeration sectors; the time available for developing countries to produce alternatives to HFCs; the impact of an HFC phase-down on future replenishments of the Multilateral Fund; how to address HCFC/HFC conversion projects developed to meet the accelerated HCFC phase-out schedule; and how the Multilateral Fund should deal with potential triple conversions, that is, situations in which plants that had received funding for CFC and HCFC conversion would seek further funding for HFC conversion.

98. Additional views expressed by resource persons and observers are summarized in annex III to the present note.

B. Approach proposed in the European Union discussion paper

99. **The European Union discussion paper**, presented at the Twenty-Sixth meeting of the parties in 2014**,** contains the party's ideas for an alternative way forward.[33] Expressing full support for the spirit of the proposed amendments, it underlines the importance of taking into consideration the specific national circumstances of Article 5 parties such as climatic conditions and the expected growth of the refrigeration and air-conditioning sector. The paper makes the following suggestions:

(a) For non-Article 5 parties:

(i) Baselines based on average HFC consumption and production levels in the years [2009–2012] and [15] per cent of the 1989 baseline for the HCFC phase-out, the latter component aiming to ensure that parties that achieve the HCFC phase-out ahead of schedule will not be penalized;

(ii) An ambitious phase-down schedule to reduce HFC consumption and production, starting with [85] per cent of baseline levels in [2017] and dropping to [15] per cent in 2030.

(b) For Article 5 parties:

(i) For HFC production, a baseline based on average HFC production in [2009–2012] and [70] per cent of the [2009–2010] baseline, a freeze of HFC production in [2019] and a longer-term reduction target to [15] per cent in [2045] (expressed in CO_2 equivalent);

(ii) For HFC consumption, a baseline based on average HFC and HCFC consumption in [2015–2016], a freeze of the combined HCFC and HFC consumption beginning in [2019] (in CO_2 equivalent) and no reduction schedule for HFC consumption but maintaining the existing HCFC phase-out schedule, with a view to agreeing on the longer-term phase-down of the combined consumption of those chemicals in the coming years.

100. The European Union notes that what distinguishes its suggested approach from the two amendment proposals is that it addresses the combined climate impacts of HCFC and HFC consumption in Article 5 parties while maintaining the HCFC consumption and production phase-out schedule agreed in 2007. The party argues that this approach provides greater regulatory flexibility and technological choice to Article 5 parties in their efforts to replace HCFCs with alternatives, because those alternatives may include HFCs as long as the climate impact of the total mix of HFCs and HCFCs is capped.

[33] UNEP/OzL.Pro.26/INF/7

101. In the short term the European Union suggests complementary actions encompassing data collection to facilitate calculation of the HFC baseline component, agreement on the reduction schedule in [2017 or 2018], on the basis of collected data, and the collection of information on alternatives to ozone-depleting substances used in individual countries to enable parties to take informed decisions on long-term measures to maximize climate benefits.

C. Schematic summary of the amendment proposals and the European Union discussion paper

Table 4
Key elements of the Federated States of Micronesia amendment proposal

	Non-Article 5		Article 5
Baseline consumption	Average HFC consumption and average HCFC consumption in 2014–2016		[A few years later, to be determined by the parties]
Baseline production	Average HFC production and average HCFC production in 2014–2016		[A few years later, to be determined by the parties]
Potential reduction steps	2017	85%	[To be determined by the parties]
	2020	70%	
	2023	55%	
	2026	45%	
	2029	30%	
	2032	15%	
	2035	10%	
Key provisions			
• Controlled substances: 21 HFCs • Limits on HFC-23 by-product emissions • Licensing of HFC imports and exports • Bans on trade in HFCs with non-parties • Bans on imports of products containing HFCs from non-parties • Bans or restrictions on imports of products produced with, but not containing, HFCs from non-parties (subject to feasibility considerations) • Transfer of consumption rights between non-Article 5 parties • Production allowance to satisfy the basic domestic needs of Article 5 parties • Reporting on HFC production and consumption as well by-product emissions of HFC-23 • Multilateral Fund funding for the phase-down of HFC production and consumption as well as the reduction of HFC-23 by-product emissions under conditions			

Table 5
Key elements of the North American amendment proposal

	Non-Article 5		Article 5	
Baseline consumption	100% of average HFC consumption and 85% of average HCFC consumption in 2008–2010		100% of average HFC consumption and 40% of average HCFC consumption in 2011–2012	
Baseline production	100% of average HFC production and 85% of average HCFC production in 2008–2010		100% of average HFC production and 40% of average HCFC production in 2011–2012	
Potential reduction steps	2018	90%	2020	100%
	2023	65%	2025	70%
	2029	30%	2031	40%
	2035	15%	2045	15%
Key provisions				
• Controlled substances: 19 HFCs • Limits on HFC-23 by-product emissions • Licensing of HFC imports and exports • Bans on trade in HFCs with non-Parties • Transfer of consumption rights between non-Article 5 parties • Production allowance to satisfy the basic domestic needs of Article 5 parties • Reporting on HFC production and consumption as well as by-product emissions of HFC-23 • Multilateral Fund funding for the phase-down of HFC production and consumption as well as the reduction of HFC-23 by-product emissions under conditions				

Table 6
Key elements of the European Union discussion paper

<table>
<tr><th></th><th colspan="2">Non-Article 5</th><th>Article 5</th></tr>
<tr><td>Baseline consumption</td><td colspan="2">Average HFC consumption in [2009–2012] plus [15%] of the 1989 baseline for the HCFC phase-out (CO_2-eq)</td><td>Average consumption of HFCs and HCFCs in [2015–2016] (CO_2-eq.)</td></tr>
<tr><td>Baseline production</td><td colspan="2">Average HFC production in [2009–2012] plus [15%] of the 1989 baseline for the HCFC phase-out (CO_2-eq)</td><td>Average HFC production in [2009–2012] plus [70%] of [2009–2010] HCFC baseline (CO_2-eq.)</td></tr>
<tr><td>Consumption freeze</td><td colspan="2"></td><td>Short term: freeze of combined HFC and HCFC consumption in [2019] (CO_2-eq)</td></tr>
<tr><td>Production freeze</td><td colspan="2"></td><td>Short term: freeze of HFC production in [2019] (CO_2-eq)</td></tr>
<tr><td rowspan="6">Potential reduction steps</td><td>2017</td><td>85%</td><td rowspan="6">Longer term: Agreement on:
• Consumption/production reduction schedules in [2017 or 2018] on the basis of collected data on HFCs
• HFC production reduction target of [85]% by [2045]</td></tr>
<tr><td>2018</td><td>65%</td></tr>
<tr><td>2021</td><td>45%</td></tr>
<tr><td>2024</td><td>30%</td></tr>
<tr><td>2027</td><td>25%</td></tr>
<tr><td>2030</td><td>15%</td></tr>
<tr><td colspan="4">Additional elements and complementary actions</td></tr>
<tr><td colspan="4">• Unaltered HCFC commitments (as stipulated in decision XIX/6)
• Data collection on the HFC baseline component of the consumption/production baselines for Article 5 parties to enable determining a long-term reduction schedule
• Begin collection of information on alternatives to ozone-depleting substances used in individual countries
• Ensure adequate funding for the HFC phase-down, including through future replenishments of the Multilateral Fund</td></tr>
</table>

VII. Funding by the Multilateral Fund for the transition to climate-friendly alternatives

A. Policies on HCFCs in response to decision XIX/6

102. By decision XIX/6, on the acceleration of the phase-out of HCFCs, the Meeting of the Parties directed the Executive Committee of the Multilateral Fund to undertake several actions to assist Article 5 parties to meet their commitments in accordance with the adjusted HCFC phase-down schedule. One important mandate for the Fund was to develop and apply funding criteria for projects and programmes, prioritizing those that were cost-effective and focused on, inter alia, substitutes and alternatives that minimized other impacts on the environment, including on the climate, taking into account global-warming potential, energy use and other relevant factors.

103. At its fifty-third meeting, in November 2007, its first after the adoption of decision XIX/6, the Executive Committee started intense discussions on modalities for phasing out HCFCs in the consumption and production[34] sectors, which concluded with the adoption of several policies and guidelines in response to the mandate from the parties. Of particular importance were the guidelines for the preparation of HCFC phase-out management plans (HPMPs) to enable Article 5 parties to meet the freeze on HCFC consumption in 2013 and the 10 per cent reduction in 2015 (stage I of HPMPs) and satisfy the criteria for funding HCFC phase-out in the consumption sector.

[34] Policy documents on HCFC phase-out in the production sector have been discussed at the fifty-fifth (UNEP/OzL.Pro/ExCom/55/45), fifty-sixth (UNEP/OzL.Pro/ExCom/56/57), and fifty-seventh (UNEP/OzL.Pro/ExCom/57/61) meetings.

Guidelines pertaining to the phase-out of HCFCs

104. The guidelines on the preparation of stage I of HPMPs were adopted by the Executive Committee in its decision 54/39, at its fifty-fourth meeting, in April 2008. Countries and implementing agencies were encouraged not to take account of not only the ozone depleting potential of HCFCs but also the global warming implications of alternative substances and technologies; they were also encouraged to exploit any potential financial incentives and opportunities to obtain additional resources.

105. At its seventy-first meeting, in December 2013, the Executive Committee in its decision 71/42 approved guidelines for funding the preparation of stage II of HPMPs. The Executive Committee requested bilateral and implementing agencies to ensure that project proposals for stage II of HPMPs provided descriptions of how HPMP strategies had considered the range of non-ozone-depleting substance technically proven and commercially available alternatives, including climate friendly alternatives to HCFCs, and a qualitative description of how the strategy for the servicing sector had taken into account climate issues. At its seventy-second meeting, in May 2014, the Executive Committee discussed the matter of minimizing the adverse climate impact of HCFC phase-out in the refrigeration servicing sector and encouraged Article 5 parties to consider, as needed and feasible, measures to limit the import of HCFC-based equipment and to facilitate the introduction of energy-efficient and climate-friendly alternatives when implementing their HPMPs.

106. With regard to guidelines for the phase-out of HCFCs in the production sector, discussions are still under way; the absence of guidelines, however, has not prevented the Executive Committee from funding the only eligible proposal that has been submitted.

Criteria for funding the phase-out of HCFCs

107. Criteria for funding stage I of HPMPs in the consumption sector in Article 5 parties were adopted by the Executive Committee in its decision 60/44, at its sixtieth meeting, in April 2010. The criteria cover the determination of the cut-off date for installation of HCFC-based manufacturing equipment, the starting point for aggregate reductions in HCFC consumption, second-stage conversions and eligible incremental costs of HCFC phase-out projects. With regard to eligible incremental costs the decision provided that funding of up to 25 per cent above the cost effectiveness threshold would be provided for projects when needed for the introduction of low-global-warming-potential alternatives.

108. The Executive Committee is currently discussing draft criteria for funding HCFC phase-out in the consumption sector for stage II of HPMPs (decision 73/64). Key issues under consideration include the funding levels required; the need to adjust the criteria for stage II of HPMPs to current circumstances; the need to address conversion in small and medium-sized enterprises; the accessibility of alternative technologies; and the task of seeking to benefit both the ozone layer and the climate simultaneously, pursuant to decision XIX/6. In the meantime, Article 5 countries are allowed to submit proposals for stage II of HPMPs immediately on the understanding that such proposals will be considered on the basis of the existing guidelines for stage I HPMPs.

109. By decision XXVI/9 the Executive Committee was requested to consider providing additional funding to conduct inventories or surveys on alternatives to ozone-depleting substances in interested Article 5 parties upon their request. Implementing agencies have indicated that they intend to submit requests from 100 countries at the seventy-fourth meeting of the Executive Committee, in May 2015.

B. Funds approved for the phase-out of HCFCs in the consumption sector

110. With the vast majority of Article 5 parties being only consumers (not producers) of HCFCs, the Multilateral Fund has approved a substantial amount of funds for HCFC phase-out projects aimed at achieving a transition to climate-friendly alternatives. These include investment projects in the foam and refrigeration manufacturing sectors, projects in the refrigeration servicing sector, projects in other manufacturing sectors as well as demonstration projects. In document UNEP/OzL.Pro/ExCom/71/57 the Multilateral Fund secretariat analysed the HCFC phase-out in the various sectors based on the total amount of HCFCs to be phased out in stage I HPMPs as recorded in the parties' agreements with the Executive Committee of the Multilateral Fund. A summary of key elements of that analysis, including with regard to replacement technologies, funds approved and cost-effectiveness values,[35] is presented in the following sections.[36]

1. Investment projects

111. In **the foam sector,** funds for stage I of HPMPs were approved in the two main foam subsectors: the rigid polyurethane foam sector, including integral skin applications, where HCFC-141b is used as a blowing agent (and to a lesser extent HCFC-22 as a co-blowing agent), and the extruded polystyrene foam sector, where a mixture of HCFC-22 and HCFC-142b is usually used as a blowing agent. Implementation of rigid polyurethane foam projects approved in stage I (38 countries) is expected to result in the complete phase-out of HCFC-141b (both in bulk and in imported polyols) used as a foam blowing agent in 19 countries. In the case of the extruded polystyrene foam sector, projects were approved in stage I for six countries, five of which will result in the complete phase-out of HCFC-22 and/or HCFC-142b used in the sector.

112. In addition, HPMPs for six countries included projects for adapting locally-owned systems houses for manufacturing non-HCFC-141b pre-blended polyol systems and, through them, converting large numbers of downstream foam enterprises. Additional funding was also approved for technical assistance for systems houses in four countries aiming at reducing demand for HCFC-141b by a large number of small and medium-sized enterprises, as well as the overall cost of conversion, as many enterprises will choose to convert to one of the non-HCFC-based formulations even before stage II commences.

113. In the **refrigeration and air-conditioning manufacturing sector,** funds for stage I of the HPMPs were approved for 14 Article 5 parties for projects targeting the conversion of HCFC-22-based refrigeration and air-conditioning equipment to alternative technologies (primarily HFC-410A, HFC-32 and R-290). It is expected that the incremental capital costs associated with the HFC-410A technology in the air-conditioning sector (available globally) will be lower than those where HFC-32 technology is used, as the latter is a flammable substance requiring the installation of safety equipment and systems.

114. The key elements of the HCFC phase-out investment projects in the consumption sector are displayed in Table 7.

[35] For the calculation of the cost-effectiveness value of a given proposed project, the Multilateral Fund secretariat reviews the project based on, *inter alia*, the equipment in the baseline, the number of products manufactured, the quantity of ozone-depleting substances and other raw materials used and the alternative technology selected. Once all technical and cost issues have been satisfactorily addressed and an agreement has been reached between the Secretariat and relevant bilateral and implementing agencies, the cost-effectiveness of the project is calculated by dividing the agreed level of funding by the total quantity of ozone-depleting substances to be phased out. In cases where an enterprise is partially owned by investors from non-Article 5 parties, the agreed level of funding is adjusted by deducting an amount that is proportional to the foreign share of ownership of the enterprise.

[36] Funds approved at the seventy-third meeting of the Executive Committee for stage I of the HCFC phase-out plan for the Democratic People's Republic of Korea are not included in the tables presented.

Table 7
HCFC phase-out investment projects in the consumption sector

Sector and no of countries covered	ODS	(ODP t)	Replacement technology	Approved (US $)	Cost (US $)		Average CE (US$/kg)
					Capital	Operating	
Rigid PU foam 38 Countries	HCFC-141b	3,398.59	Cyclopentane Methyl formate HFC-245fa Water/CO_2 Pentane	174,090,016	78,894,130	4,266,185	5.63
Systems houses 6 countries		902.43		32,793,024	25,523,114	6,414,304	4.08
XPS foam 6 countries	HCFC-22	488.6	CO_2/MF CO_2/DME CO_2/DME/HFO HFC-152a Isobutane HFC-152a/DME	68,761,089			4.09
	HCFC-142b	514,8					
RAC 14 countries	HCFC-22	1,344.6	HFC-32 HFC-410A R-290 HFC-404 Ammonia/R-290 HFC-410A/R-290 HFC-32/CO_2/ Ammonia/HC	187,155,727	21,091,070	20,724,356	7.50
	HCFC-141b	55.5					
Total funds approved for investment projects				**462,799,856**			
Funds for technical assistance				**4,856,003**			

Abbreviations: ODS, ozone-depleting substance; ODP t, ozone-depletion potential tonnes; CE, cost effectiveness; PU, polyurethane; XPS, extruded polystyrene; RAC, room air-conditioning
Source: Secretariat of the Multilateral Fund

2. Projects in the refrigeration servicing sector

115. In many countries ozone-depleting substances are used solely in the refrigeration servicing sector.[37] The Executive Committee has always prioritized the phase-out of ozone-depleting substances in this sector, through funding for training programmes on good service practices for technicians, and for stand-alone recovery and recycling projects, which have been approved since as early as 1991 (table 8).

116. Although the criteria for funding HCFC phase-out in the consumption sector were developed to achieve the 2013 and 2015 phase-out targets, the Executive Committee agreed that projects that accelerated the phase-out of HCFC consumption could be considered on a case-by-case basis for low-volume consuming countries that demonstrated a strong commitment to supporting accelerated phase-out (decision 60/15). As a result, 70 of the 86 low-volume consuming countries with approved HPMPs committed to reducing their HCFC consumption baseline by 35 per cent by 2020, followed by nine low-volume-consuming countries that submitted their stage I HPMPs requesting funding for the complete phase-out of HCFC consumption in advance of the deadlines set out in the Montreal Protocol.

117. Activities in the refrigeration servicing sector were also included in the majority of HPMPs for non-low-volume-consuming countries with investment activities. Five non-low-volume-consuming Article 5 parties agreed to further reductions of HCFC-22 consumption in the refrigeration servicing sector without assistance from the Multilateral Fund.

118. Implementation of activities in the refrigeration and air-conditioning servicing sector included in stage I of HPMPs is expected to result in the complete phase-out of HCFC-141b used as a solvent for flushing refrigeration circuits in 25 countries. The total funds approved for projects in the refrigeration servicing sector amount to $136,191,738.

[37] Based on the information from approved HPMPs, about 95 Article 5 parties consume HFCF-22 solely for servicing existing refrigeration and air-conditioning equipment, while 50 countries have, in addition, enterprises that use HCFCs in manufacturing.

3. Projects in other manufacturing sectors

119. Only two HCFC phase-out investment projects in other manufacturing sectors have been included in stage I HPMPs: one for the phase-out of HCFC-22 and HCFC-141b used in the manufacturing of technical aerosol products and the other for the phase-out of HCFC-141b in the solvent sector, as indicated in table 8.

Table 8
HCFC phase-out projects in other manufacturing sectors

Sector and no of countries covered	ODS	(ODP t)	Replacement technology	Approved (US $)	CE (US$/kg)
Aerosol 1 country	HCFC-22	3.3	HCs HFC-152a HFC-134a HFC-365mfc/HFC-227ea	520,916	3.80
	HCFC-141b	7.8			
Solvents 1 country	HCFC-141b	69.0	Siloxane (KC-6)[38]	5,000,000	7.97
Total funds approved				**5,520,916**	

Abbreviations: ODS, ozone-depleting substance; ODP t, ozone-depletion potential; CE, cost effectiveness
Source: Secretariat of the Multilateral Fund

4. Demonstration projects

120. By decision XXV/5 the Meeting of the Parties requested the Executive Committee to consider the information provided in the report on additional information on alternatives to ozone-depleting substances prepared by the Technology and Economic Assessment Panel pursuant to decision XXIV/7[39] and other related reports, with a view to considering whether additional demonstration projects to validate low- GWP alternative substances and technologies, together with additional activities to maximize climate benefits, would be useful in assisting Article 5 parties in further minimizing the environmental impact of HCFC phase-out.

121. In response to decision 71/51, by the Executive Committee at its seventy-first meeting, in December 2013, the secretariat prepared an overview of approved HCFC demonstration projects, including the countries and regions covered and the technologies selected. Table 9 provides an overview of such projects.

122. In addition, the Executive Committee decided at its seventy-second meeting that proposals for demonstration projects for low-GWP alternatives to HCFCs would be considered at its seventy-fifth and seventy-sixth meetings. Decision 72/40, in paragraph (b), sets out the criteria to be applied when selecting projects and the total amount of funding for such projects, which is not to exceed $10 million.

[38] Any organic or inorganic chemical compounds of silicon, oxygen and usually carbon and hydrogen, based on the structural unit R_2SiO, where R is an alkyl group, usually methyl.

[39] Decision XXIV/7 requested the Technology and Economic Assessment Panel to prepare a report with updated information on alternative substances and technologies in various sectors for consideration by the Twenty-Fifth Meeting of the Parties.

Table 9
Overview of HCFC demonstration projects approved*

Parameters	PU foam	XPS foam	Food process and storage refrigeration	Compressors	Air-conditioning manufacturing	Solvents	Total
Number of projects	7	2	1	1	2	1	14
Cost (US $)	4,072,904	2,138,300	3,964,458	1,875,000	5,255,843	557,667	17,864,172
Impact (ODP tonnes)	11.98	12.30	13.75	N.A.	16.60	3.10	57.73
Technologies demonstrated	Methyl formate Methylal Pre-blended HCs Super critical CO_2	HFO-1234ze CO_2/Methyl formate	NH_3/CO_2	HC-290	HC-290 HFC-32	Iso-paraffin / siloxane (KC-6)	

Abbreviations: PU, polyurethane; XPS, extruded polystyrene
Source: Secretariat of the Multilateral Fund
*Regional distribution and number of approved projects: Egypt (1), China (8), Turkey (1), Brazil (2), Colombia (1), Mexico (1); no demonstration projects pursuant to decision 55/43 have been implemented in low-volume-consuming countries.

123. The alternative technologies introduced by the demonstration projects have been independently assessed through an exhaustive analysis of their performance and costs under local conditions prevailing in Article 5 countries. The results of these demonstration projects have been documented in reports submitted to the Executive Committee and disseminated through workshops attended by government and industry representatives from the regions where the projects were implemented. Several of those technologies have been incorporated into HPMPs as shown in table 10.

Table 10
Penetration of technologies demonstrated

Sector	Technology	Countries with ongoing projects introducing the technology	Estimated HCFC phase-out (mt)
Foam	Methyl formate	Brazil, Bosnia and Herzegovina, Cameroon, the Dominican Republic, Egypt, El Salvador, Indonesia, Jamaica, Mexico, Nigeria, South Africa, Trinidad and Tobago	5,000
	Methylal	Brazil, Mexico	300
	Supercritical CO_2	The Philippines	43
	Pre-blended HC	China, Egypt and Mexico	*n.a.
Refrigeration & air-conditioning	Ammonia/CO_2	China, Indonesia	*n.a.
	HC-290	Armenia, China, Serbia	3,741
	HFC-32	Algeria, Indonesia, Thailand	4,594
Solvent	Iso-paraffin/ siloxane (KC-6)	China	*n.a.

Source: Secretariat of the Multilateral Fund
*Not yet available.

5. Other projects

124. In addition to the projects mentioned above, the Multilateral Fund has approved a project promoting low-GWP refrigerants for air-conditioning sectors in high-ambient temperature countries in West Asia, in the amount of $520,000, and district cooling projects associated with ozone-depleting substance phase-out plans in two Article 5 parties, Colombia and the Maldives, in the amount of $500,000 in the case of Colombia.

C. Funds approved for the preparation and implementation of stage II HPMPs in the consumption sector

125. Since its adoption of the guidelines for funding the preparation of stage II of HPMPs at its seventy-first meeting, the Executive Committee has approved such funding for 31 countries, in the total amount of $7,138,000.

126. At its seventy-third meeting, the Executive Committee approved in principle the first funding for implementation of stage II of an HPMP, in the amount of $11.09 million for Mexico, to reduce HCFC consumption by 67.5 per cent of the party's baseline over the period 2014–2022. Funding for stage II of additional HPMPs is expected to be approved in 2015.

D. Funds approved for the phase-out of HCFCs in the production sector

127. At its sixty-ninth meeting, in April 2013, the Executive Committee approved funding for stage I of the HCFC production phase-out management plan (HPPMP) for China in the amount of US $95 million to meet the freeze and 10 per cent reduction of China's Montreal Protocol HCFC production baseline, on the condition that total compensation for the entire Chinese HCFC production sector did not exceed $385 million. The Government of China agreed to coordinate with its stakeholders and authorities to make its best efforts to manage HCFC production and associated by-product production in HCFC plants in accordance with best practices to minimize climate impacts and to optimize the implementation of the HPPMP in order to minimize environmental and climate impacts as much as possible, including by giving priority to HCFC production closure to achieve the HCFC reduction targets set forth in decision XIX/6.

E. Impact on climate from alternatives to HCFCs

128. The secretariat of the Multilateral Fund presented at its seventy-first meeting |(December 2013) a simplified calculation of the impact on the climate of HCFCs and their replacements for every year of manufacture.[40] The calculation was based on the assumption that all HCFCs used are released into the atmosphere at the same time. , According to the secretariat's estimates, the annual HCFC consumption of 82,114.7 metric tonnes (6,812.0 ODP-tonnes) to be phased out in the manufacturing sector is equivalent to approximately 107.0 million tonnes of CO_2-equivalent emissions. The amount of alternatives phased in as replacements to those HCFCs, however, is equivalent to 27.7 million tonnes of CO_2-equivalent emissions. As a result, for each year of manufacturing, the substances used after conversion have, when released, an impact on the climate that is lower than the impact of the equivalent amount of HCFCs by 79.4 million of CO_2-equivalent tonnes.

[40] UNEP/OzL.Pro/ExCom/71/57, paragraphs 75-77.

F. Total funding approved by the Multilateral Fund for the transition to climate-friendly alternative substances and technologies

129. On the basis of the above analysis, it can be concluded that as of February 2015 the Executive Committee of the Multilateral Fund had approved funding in the amount of $734,340,457 for the consumption and production sectors as shown in Table 11.

Table 11
Total funds approved for projects transitioning to climate friendly alternatives to HCFCs ***(as at February 2015)***

Sector	Funds approved (US $)
Consumption (stage I HPMPs)	
Foams, refrigeration & air-conditioning	**462,799,856**
Technical assistance	**4,856,003**
Refrigeration servicing	**136,191,738**
Aerosols	**520,916**
Solvents	**5,000,000**
Demonstration projects	**17,864,172**
Other projects*	**1,020,000**
Consumption (stage II HPMPs)	
Aerosols, refrigeration servicing	**11,087,772**
Production (stage I HPPMPs)	
Production	**95,000,000**
Grand total	**734,340,457**

Source: Secretariat of the Multilateral Fund
*Including $0.5 million for a chiller project in Colombia used in a district cooling project.

VIII. Funds approved under the ozone and climate financial regimes

130. Table 12 presents the total funds approved under the Multilateral Fund for the transition from ozone-depleting substances to climate-friendly alternatives, along with funds approved and invested for HFC-related projects through the GEF and HFC abatement projects under the Clean Development Mechanism. Although a comparison of the figures displayed is not straightforward, there is scope for assessing the relative importance of the Multilateral Fund in supporting efforts to avoid the use of HFCs compared to that of climate-related funds and mechanisms to abate HFC emissions.

Table 12
Total funds approved under the Multilateral Fund and Framework Convention on Climate Change for HFC-related projects

Funding source	Total funds approved (US $)
Montreal Protocol	
Multilateral Fund *	**734,340,457**
UNFCCC	
Global Environment Facility **	**10,950,000**
Clean Development Mechanism ***	**140,000,000**
Joint Implementation ***	**N/A**

Sources: (*) Secretariat of the Multilateral Fund; (**) Global Environment Facility; (***) Framework Convention on Climate Change secretariat

Concluding remark

131. The present note provides an overview of the major issues surrounding HFCs and their management on the basis of available information and discussions held by the Parties to the Montreal Protocol to date. The Parties may wish to refer to this note while deliberating on those issues during the thirty-fifth meeting of the Open-ended Working Group of the Parties to the Montreal Protocol.

Annex I

Technology and Economic Assessment Panel reports on alternatives to high-global warming potential HFCs

The present annex contains a list of major reports prepared by the Technology and Economic Assessment Panel on alternatives to high-global warming potential HFCs in response to requests by the Meeting of the Parties in specific decisions. The reports are listed in chronological order.

"The Implications to the Montreal Protocol of the inclusion of HFCs and PFCs in the Kyoto Protocol" (October 1999) – prepared by the Panel's HFC and PFC task force subsequent to a joint workshop held with IPCC in November 1998 in Petten, the Netherlands, in response to decision X/16 of the Tenth Meeting of the Parties to the Montreal Protocol (Cairo, 1998): http://ozone.unep.org/Assessment_Panels/TEAP/Reports/Other_Task_Force/HFCPFC.pdf.

"Safeguarding the Ozone Layer and the global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons" (April, 2005) – a special report prepared by the Panel and IPCC in response to decision XIV/10 of the Fourteenth Meeting of the Parties to the Montreal Protocol (Rome, November 2002). Available at: http://ozone.unep.org/Meeting_Documents/ipcc/IPCC-TEAP-Special-Report-Full.pdf.

"Supplement to the IPCC/TEAP Report" (November, 2005) – prepared by the Panel in response to a request by the Open-ended Working Group of the Parties to the Montreal Protocol at its Twenty-fifth meeting (Montreal, June 2005) for a clear explanation of the ozone depletion implications of the issues raised in the IPCC/TEAP special report in (b) above. Available at: http://ozone.unep.org/teap/Reports/TEAP_Reports/teap-supplement-ippc-teap-report-nov2005.pdf.

"Compilation of the submitted list of measures arising from the IPCC/TEAP Special Report" – contained in annex I to the report of the Ozone Secretariat on the workshop on the IPCC/TEAP special report convened (Montreal, July 2006) in response to decision XVII/19 of the Seventeenth Meeting of the Parties to the Montreal Protocol (Dakar, December 2005). Available at: http://ozone.unep.org/teap/Reports/TEAP_Reports/Workshop2-2E.pdf.

"Scoping Study on Alternatives to HCFC Refrigerants under High Ambient Temperature Conditions", contained in volume 1 of the Panel's May 2008 progress report and presented to the Open-ended Working Group of the Parties to the Montreal Protocol at its twenty-eighth meeting (Bangkok, July 2008) in response to decision XIX/8 of the Nineteenth Meeting of the Parties to the Montreal Protocol (Montreal, September 2007). Available at: http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/Teap_progress_report_May2008.pdf.

"Assessment of Alternatives to HCFCs and HFCs and Update of the TEAP 2005 Supplement Report Data", report by the Panel's task force established in response to decision XX/8 (May 2009), presented at the Workshop for a Dialogue for High-Global Warming Potential Alternatives to Ozone-Depleting Substances (Geneva, July 2009) in response to decision XX/8 of the Twentieth Meeting of the Parties to the Montreal Protocol (Doha, November 2008). Available at: http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/teap-may-2009-decisionXX-8-task-force-report.pdf.

"Environmentally Sound Management of Banks of Ozone-Depleting Substances" (October 2009), phase 2 report of the Panel's task force established in response to decision XX/7 – presented to the Twenty-First Meeting of the Parties to the Montreal Protocol (Port Ghalib, November 2009) in response to decision XX/7 of the Twentieth Meeting of the Parties to the Montreal Protocol (Doha, November 2008). Available at: http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/teap-october-2009-decisionXX-7-task-force-phase2-report.pdf.

2010 progress report of the Technology and Economic Assessment Panel, volume 1, entitled "Assessment of HCFCs and Environmentally Sound alternatives", "Scoping study on Alternatives to HCFC refrigerants under High Ambient Temperature conditions" (May 2010), prepared in response to decision XXI/9 of the Twenty-First Meeting of the Parties to the Montreal Protocol (Port Ghalib, November 2009).Available at: http://ozone.unep.org/Assessment_Panels/TEAP/Reports/TEAP_Reports/teap-2010-progress-report-volume1-May2010.pdf.

"Decision XXIII/9 Task Force Report – Additional Information on Alternatives to Ozone-depleting Substances", May 2012 report of the Technology and Economic Assessment Panel, volume 2, presented to the Open-ended Working Group of Parties to the Montreal Protocol at its Thirty-second meeting (Bangkok, July 2012) in response to decision XXIII/9 of the Twenty-Third Meeting of the Parties to the Montreal Protocol (Bali, November 2011). Available at: http://conf.montreal-protocol.org/meeting/oewg/oewg-32/presession/Background%20Documents/teap-task-force-XXIII-9-report-may2012.pdf.

"Decision XXIV/7 Task Force report – Additional Information on Alternatives to ODS" – Final report presented to the Twenty-Third Meeting of the Parties to the Montreal Protocol (Bangkok, October 2013) in response to decision XXIV/7 of the Twenty-Fourth Meeting of the Parties to the Montreal Protocol (Geneva, November 2012). Available at: http://conf.montreal-protocol.org/meeting/mop/mop-25/presession/Background%20Documents%20are%20available%20in%20English%20o1/TEAP_TaskForce%20XXIV-7-September2013.pdf.

"Decision XXV/5 Task Force Report – Additional Information to Alternatives on ODS" – Final report presented to the Twenty-Sixth Meeting of the Parties to the Montreal Protocol (Paris, November 2014) in response to decision XXV/5 of the Twenty-Fifth Meeting of the Parties to the Montreal Protocol (Bangkok, October 2013). Available at: http://conf.montrealprotocol.org/meeting/mop/cop10mop26/presession/Background%20Documents%20are%20available%20in%20English%20o1/TEAP_Task%20Force%20XXV5-October2014.pdf.

Annex II

Data on emissions, production and consumption of HFCs reported by parties listed in Annex I to the United Nations Framework Convention on Climate Change (UNFCCC)

1. The tables contained in the present annex display emission, production and consumption data on hydrofluorocarbons (HFCs) reported historically by parties to the United Nations Framework Convention on Climate Change under the Convention. Although such data are available for each year within the period 1990–2012, for the purpose of the present note data are displayed for the years 1990, 1995, 2000 and each year thereafter until 2012. In considering the data, the reader should take note of the following specifications:

(a) Data for the European Union are reported separately from those of its member States. The entry "European Union-15" in a number of the tables refers to the following European Union member States: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom. The entry "European Union-28" refers to the 28 current Member States of the European Union;

(b) Blank cells indicate that parties have filled the corresponding cells on their reporting forms with either zero or the following abbreviations: NA (Not Available), NO (Not Occurring), C (Confidential), NE (Not Estimated), IE (Included Elsewhere);

(c) Countries with blank cells for all the years displayed have been removed from the table;

(d) Table 1 (Annual HFC emission data reported by Annex I parties under the United Nations Framework Convention on Climate Change) is reproduced as it appears on the website of the Convention. It can be accessed through the following link: http://unfccc.int/ghg_data/ghg_data_unfccc/time_series_annex_i/items/4126.php;

(e) Table 2 (Annual HFC production data reported by Annex I parties under the United Nations Framework Convention on Climate Change) has been compiled and provided to the Ozone Secretariat by the secretariat of the Convention. Data are extracted from the Common Reporting Format (CRF) tables of each party's latest 2014 greenhouse gas inventory submission as of 28 January 2015. Values represent the national aggregated HFC production based on corresponding data for each HFC type reported by each party in CRF tables: table2(II)s1 and table2(II)s2. The CRF tables can be accessed on the Convention's inventory submissions webpage: http://unfccc.int/8108.php;

(f) Table 3 (Annual HFC consumption data reported by Annex I parties under the United Nations Framework Convention on Climate Change) has been compiled and provided to the Ozone Secretariat by the secretariat of the Convention. Data are extracted from the Common Reporting Format (CRF) tables of each party's latest 2014 greenhouse gas inventory submission as of 28 January 2015. Values represent the national aggregated HFC consumption based on corresponding data for each HFC type as reported by each party in CRF tables: table2(II).Fs1 and table2(II).Fs2. The CRF tables can be accessed on the Convention's inventory submissions webpage: http://unfccc.int/8108.php.

2. Some parties have been reporting large amounts of HFC consumption as "Unspecified mix of HFCs". These are included in the aggregated figures. In response to the Ozone Secretariat's request for further clarification on those data, the Convention secretariat explained that national emissions are calculated by the parties themselves and that detailed information about the methodologies they use in doing so may be found in the national inventory reports available on the Convention website.[41] Furthermore, any issues identified during the review process, are addressed in the corresponding review reports, also available through the same site.[42]

[41] https://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php.

[42] https://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_reports/items/8452.php.

3. The secretariat has not made any attempt to analyse the data contained in the present annex but presents them as available on the website of the Framework Convention on Climate Change (emissions data) and as provided by the secretariat of that Convention (production and consumption data). In considering the data parties should bear in mind that the definition of production and consumption under the Framework Convention on Climate Change may not be identical to that under the Montreal Protocol.

Table 1: Annual HFC emissions data reported by Annex I parties under the United Nations Framework Convention on Climate Change (Gg CO_2 equivalent)

	Base year	1990	1995	2000	2005	2010	2011	2012	Change* (%)
Australia	1,126	1,126	798	1,375	4,259	6,943	7,512	7,945	605.4
Austria	23	23	340	647	997	1,286	1,349	1,431	6,247.9
Belarus			3	9	26	13			
Belgium			449	933	1,460	1,999	2,076	2,140	
Bulgaria			2	18	114	372	410	456	
Canada	767	767	479	2,936	5,296	7,073	7,547	7,783	914.4
Croatia			49	171	333	472	485	486	
Cyprus			2	29	121	250	259	260	
Czech Republic			0	178	617	1,689	1,925	2,083	
Denmark			218	613	819	823	778	679	
Estonia			25	70	118	153	160	167	
European Union (15)	27,832	27,832	40,197	44,419	54,526	68,963	70,304	71,540	157.0
European Union (28)	27,832	27,832	40,560	46,682	62,436	81,570	84,110	85,898	208.6
Finland	0	0	29	492	863	1,170	1,032	926	-
France	3,657	3,657	1,761	5,984	11,746	15,809	16,772	16,968	364.0
Germany	4,592	4,592	7,008	7,430	8,448	8,877	9,153	9,346	103.5
Greece	935	935	3,290	4,244	4,067	3,603	3,410	3,889	315.9
Hungary			38	237	682	1,039	1,145	1,006	
Iceland			8	36	58	123	121	144	
Ireland	0	0	37	271	813	973	992	982	-
Italy	351	351	680	1,838	5,148	8,299	8,804	9,246	2,534.3
Japan	12,595	12,595	20,260	18,800	10,518	18,291	20,452	22,926	82.0
Latvia			1	5	28	72	75	84	
Liechtenstein	0.00	0.00	0.84	2.95	5.92	7.87	7.98	8.33	-
Lithuania			3	14	68	192	220	241	
Luxembourg	12	12	16	29	53	66	67	67	460.1
Malta				8	64	121	132	171	
Monaco	0.29	0.29	0.53	4.72	5.24	6.26	6.99	6.39	2,106.9
Netherlands	4,432	4,432	6,019	3,891	1,511	2,257	2,132	2,055	-53.6
New Zealand			123	253	712	1,078	1,817	1,805	
Norway	0	0	80	327	524	914	950	972	-
Poland			197	1,352	5,100	6,756	7,394	7,700	
Portugal			27	243	736	1,368	1,493	1,667	
Romania	0	0	2	64	323	855	946	1,033	-
Russian Federation	28,410	28,410	12,214	21,022	15,423	10,960	9,406	11,338	-60.1
Slovakia			12	77	206	420	440	452	
Slovenia			32	41	133	215	217	219	
Spain	2,441	2,441	4,880	8,448	5,959	8,203	7,790	7,574	210.3
Sweden	4	4	132	568	791	848	820	775	-
Switzerland	0	0	182	501	905	1,138	1,195	1,245	-
Turkey				818	2,379	4,009	5,308	4,681	
Ukraine				14	254	658	717	726	
United Kingdom	11,384	11,384	15,326	8,863	11,254	13,565	13,825	13,989	22.9
United States	36,924	36,924	64,585	107,674	119,802	143,966	148,559	151,229	309.6

Source: Framework Convention on Climate Change

* Change from base year to latest reported year (per cent).

Dashes indicate that the change is more than 10,000 per cent.

Table 2: Annual HFC production* data reported by Annex I parties under the United Nations Framework Convention on Climate Change (tonnes)

	Base year	1990	1995	2000	2005	2010	2012
European Union (15)**	12.1	12.1	19,183.7	56,982.7	110,407.9	118,854.3	127,445.9
France			8,762.0	10,631.0	21,587.0	18,688.6	19,255.2
Italy			2,489.0	8,410.0	15,280.0		206.0
Japan**	1,500.0	1,500.0	1,723.0	43,986.1	75,036.3	39,793.1	40,683.1
Russian Federation			0.0	189.0	1,266.7	239.7	76.0
United Kingdom of Great Britain and Northern Ireland**	11.4	11.4	6,970.4	35,032.5	70,471.4	96,743.5	102,139.8
United States of America**	384.9	384.9	43,920.4	87,183.2	111,609.0	164,442.2	173,262.9

Source: Framework Convention on Climate Change

* The definition of production under the Framework Convention on Climate Change may not be identical with that under the Montreal Protocol.

**Figures include amounts reported as "unspecified mix of HFCs" by the party.

Table 3: Annual HFC consumption* data reported by Annex I parties under the United Nations Framework Convention on Climate Change (tonnes)

	Base year	1990	1995	2000	2005	2010	2012
Australia			2,599.3	18,247.1	50,222.7	86,278.2	98,633.1
Austria**	2,169.7	2,169.7	10,152.3	18,502.5	21,614.0	26,401.8	26,379.2
Belgium			2,279.8	6,000.3	9,840.6	15,218.9	17,149.9
Bulgaria			79.7	621.2	2,885.2	7,757.5	9,431.5
Canada			3,102,343.8	11,585.2	18,132.1	23,242.2	26,399.3
Croatia			136.8	647.4	1,202.4	1,670.7	1,742.4
Czech Republic			19.3	3,319.4	12,983.2	25,734.1	29,919.5
Denmark			1,172.2	4,073.7	4,583.6	3,989.1	3,399.7
Estonia			85.7	492.6	999.5	1,917.0	2,040.2
European Union (15)**	2,142,016.7	2,142,016.7	9,510,571.0	306,049,013.1	2,594,013,005.7	3,157,154,130.9	3,293,463,451.2
Finland			69.3	414.6	505.8	627.0	669.6
France**	2.7	2.7	3,931.5	390,945.4	3,591,504.3	4,171,485.8	4,475,679.9
Germany			8,351.1	27,849.1	43,296.6	53,783.5	57,486.8
Greece			450.2	3,390.1	12,695.3	18,053.8	18,266.1
Hungary			39.7	311.4	1,763.9	3,087.8	3,382.8
Iceland			26.2	143.8	334.3	951.0	1,147.6
Ireland			151.7	1,257.2	2,454.1	3,750.6	3,804.5
Italy			1,573.6	16,966.6	2,079,356.3	3,771,922.4	4,474,460.2
Japan**	1,516.5	1,516.5	562,908.4	589,894.6	518,005.1	803,453.3	798,455.9
Latvia			11.2	484.1	2,863.7	6,997.3	8,554.3
Liechtenstein	-	-	4.5	36.8	961.1	4,142.3	8,858.4
Lithuania			39.7	133.5	446.2	1,161.9	1,434.7
Luxembourg	9.3	9.3	10.5	22.8	43.3	107.4	133.9
Monaco	5.1	5.1	194.1	764.2	2,381.7	3,366.6	3,572.1
Netherlands			120.4	628.4	1,008.7		
New Zealand			122.0	728.7	1,835.2	2,979.1	3,307.7
Norway**	6.0	6.0	46,212.3	393,872.9	558,873.3	389,560.6	270,622.1
Poland			536.2	6,315.7	16,383.3	28,834.2	32,821.9
Portugal			9,334.0	18,912.5	29,969.0	94,463.1	134,031.4
Romania	0.2	0.2	138.6	823.8	2,497.6	5,324.2	5,952.7
Russian Federation			110.3	1,247.0	5,820.5	17,856.7	28,036.1
Slovakia			135.4	615.2	1,164.8	1,521.3	1,684.7
Slovenia			366.5	415.2	744.7	1,004.2	1,042.9
Spain	28.5	28.5	1,299.1	7,628.5	18,107.8	24,825.4	24,847.6
Sweden	82.0	82.0	2,019.8	6,091.7	8,585.4	9,580.7	9,186.2
Switzerland	0.5	0.5	1,476.2	3,467.9	6,174.2	7,659.3	8,420.3
Ukraine				21.6	958.6	2,261.3	2,864.8
United Kingdom of Great Britain and Northern Ireland	17.3	17.3	5,916.7	24,205.7	41,643.4	52,618.3	54,250.4
United States of America**	746,894.9	746,894.9	4,331,590.2	15,182,237.6	83,445,372.0	168,828,936.6	207,398,674.3

Source: Framework Convention on Climate Change

* The definition of consumption under the Framework Convention on Climate Change may not be identical with that under the Montreal Protocol.

** Figures include amounts reported as "unspecified mix of HFCs" by the party.

Annex III

Discussions on proposed approaches to controlling HFCs under the Montreal Protocol – views expressed by resource persons and observers

A. Resource persons

1. A number of resource persons representing the secretariat of the United Nations Framework Convention on Climate Change, international institutions and organizations and private sector entities had the opportunity to share their views at the 2014 workshop organized by the Secretariat. Some of the views expressed on the legal, technical and economic challenges involved in the proposed approaches are summarized in the following paragraphs.

2. With respect to **legal challenges**, it was said that the rules of customary international law relating to the law of treaties, as codified in the provisions of the 1969 Vienna Convention on the Law of Treaties, enabled the ozone and climate regimes to work in synergy. It was said that concerns about a conflict between the climate and ozone regimes could be addressed by the inclusion of a clause in any amendment to the Montreal Protocol clarifying its effect on the climate treaties. In the absence of such a clarifying clause, paragraph 4 of article 30 of the Vienna Convention on the Law of treaties, governing the application of successive treaties on the same subject, would apply.

3. A legal conflict would arise if compliance with the provisions of one agreement made it impossible for a party to comply with the provisions of the other agreement. In that situation, there might be a case for dealing with some legal "wrinkles", such as the text in the Framework Convention on Climate Change and the Kyoto Protocol referring to the Montreal Protocol; such issues could be addressed in the negotiations on the new climate treaty, possibly through a specific "carve-out" for HFCs.

4. Existing precedents for the control of greenhouse gas emissions by institutions outside the climate regime have been cited, including with regard to aviation and maritime emissions, which are being addressed by the International Civil Aviation Organization and the International Maritime Organization, respectively.

5. An example of how different regimes could work together in a mutually supportive manner can be seen in the process for promoting synergies between the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade and the Stockholm Convention on Persistent Organic Pollutants.

6. Reference was also made to decision XIII/29 of the Thirteenth Meeting of the Parties, which includes a commitment to support appropriate collaboration and synergies between multilateral environmental agreements, as agreed by the parties to those agreements, and the 2004 Prague Declaration on Enhancing Cooperation Among Chemicals-Related Multilateral Environmental Agreements, which called on parties to various multilateral environmental agreements to work together in achieving the sustainable development objectives of the 2002 World Summit on Sustainable Development.

7. On **key technical issues**, resource persons said that it was necessary to focus on safety and flammability; consider environmental impacts in addition to GWP; support demonstration projects on, for instance, carbon dioxide refrigeration in supermarkets in tropical Article 5 parties and transport refrigeration; develop cost-effective solutions for small and medium-sized enterprises and alternatives to HFCs used in the extruded polystyrene industry; develop a clear picture of risks; and consider the use of "lower-GWP" rather than "low-GWP" HFCs in developing countries.

8. It was noted that many developing countries had imported standards from developed country regions rather than develop their own, which meant that in some cases standards were either too stringent or difficult to interpret and implement in the importing countries.

9. Concerning strategies for replacing HFCs and HCFCs in installed air-conditioning and refrigeration equipment, a starting point could be to require the use of low-GWP alternatives in certain sectors, as a number of countries had done under their HCFC phase-out management plans. Additional steps included consideration of how to design buildings that required less heating and refrigeration and ensuring proper equipment servicing and retirement, including through leak repairs and destruction of refrigerants at the end of equipment life.

10. It was also mentioned that industry was divided with regard to the use of flammable alternatives and that caution was warranted before adopting phase-outs. With regard to not-in-kind technologies, it was said that the expansion of cities as a result of massive rural-to-urban migration created an opportunity to design new buildings with remote cooling and heating systems that significantly reduced energy consumption and HFC emissions.

11. On **financial issues** it was suggested that tackling HFCs under the Montreal Protocol would require reforming the Multilateral Fund to enable it to finance costs associated with energy efficient technologies and patents, as significant increases in energy use and greenhouse gas emissions were projected in some developing countries. The effectiveness of the Fund was widely acknowledged compared to other funding mechanisms. Although GEF could consider HFC emission reductions, its focus to date had been primarily on improving energy efficiency and reducing carbon dioxide emissions; the Clean Development Mechanism, the Green Climate Fund and the Climate Technology Centre and Network were all capable of addressing emissions, including HFC emissions, within the climate change context. Lessons learned from the Multilateral Fund could be particularly useful to the Green Climate Fund and the Climate Technology Centre and Network; caution should be exercised, however, to avoid duplication of efforts.

12. On the question of barriers to accelerating technology transfer to Article 5 parties, it was said, inter alia, that the technologies concerned were often incompatible with local standards and conditions, including high ambient temperatures; that companies were unwilling to share patents for fear of losing their competitive edge and that the Multilateral Fund should do more to assist countries that were unable to afford lower-GWP technologies for HFC phase-down.

13. The potential benefits of South-South technology transfer and demonstration of innovative technologies were also highlighted, along with training, transparent and equitable standard-setting, open and fair procurement procedures, and assistance for developing countries in analysing the barriers to and creating an enabling environment for the most appropriate transfers.

B. Observers

14. At some meetings of the parties to the Montreal Protocol, representatives of industry groups from developing countries expressed concerns about the challenges that potential reductions in HFCs would pose for industry. Viable alternatives, they said, were required before the issue could be discussed further.

15. On the other hand, representatives of environmental non-governmental organizations have persistently stressed at the meetings of the parties the need for immediate measures to deal with HFCs, maintaining that HFC-free alternatives are available and that the technology needed to address a huge proportion of HFC uses is already available. Speaking strongly in favour of the proposed amendments, they argue that all that is needed is political will and financial commitment.