# MONTREAL PROTOCOL

# ON SUBSTANCES THAT DEPLETE

# THE OZONE LAYER

UNEP

## REPORT OF THE
## TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL

## MAY 2011

## ASSESSMENT OF THE FUNDING REQUIREMENT FOR THE REPLENISHMENT OF THE MULTILATERAL FUND FOR THE PERIOD 2012-2014

# UNEP
# MAY 2011 REPORT OF THE TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL

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**Montreal Protocol**
**On Substances that Deplete the Ozone Layer**

Report of the
UNEP Technology and Economic Assessment Panel

May 2011

**ASSESSMENT OF THE FUNDING REQUIREMENT FOR THE REPLENISHMENT OF THE MULTILATERAL FUND FOR THE PERIOD 2012-2014**

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**MAY 2011 REPORT OF THE TECHNOLOGY AND ECONOMIC ASSESSMENT PANEL**

# ASSESSMENT OF THE FUNDING REQUIREMENT FOR THE REPLENISHMENT OF THE MULTILATERAL FUND FOR THE PERIOD 2012-2014

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## ACKNOWLEDGEMENT

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The opinions expressed are those of the Panel and its Task Force and do not necessarily reflect the reviews of any sponsoring or supporting organisation.

The TEAP and its Replenishment Task Force thank UNEP in Geneva, Switzerland, for hosting the meeting, 8-12 May 2011, where this report was discussed and proposals were made for last round changes, after which a last review took place by email circulation.

# Foreword

## The May 2011 TEAP Report

The May 2011 TEAP Report consists of two volumes:
***Volume 1***: May 2011 TEAP Progress Report
***Volume 2***: May 2011 TEAP Replenishment Task Force Report

**Volume 1**
Volume 1 contains the MTOC essential use report, progress reports, the XXII/10 report on destruction, the MB CUN report, and TEAP-TOC nomination issues as requested by Decision XXII/22.

**Volume 2**
Volume 2 is the Assessment Report of the TEAP Replenishment Task Force of the Funding Requirement for the Replenishment of the Multilateral Fund during 2012-2014, in response to Decision XXII/3 (this report).

The UNEP Technology and Economic Assessment Panel:

| | | | |
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# ASSESSMENT OF THE FUNDING REQUIREMENT FOR THE REPLENISHMENT OF THE MULTILATERAL FUND FOR THE PERIOD 2012-2014

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# Executive Summary

## 1 Mandate

Consistent with Decision XXII/3 of the Twenty Second Meeting of the Parties the Technology and Economic Assessment Panel (TEAP) has prepared a report for submission to the Twenty-third Meeting of the Parties, through the Open-ended Working Group at its 31st meeting in 2011, to enable the Twenty-third Meeting of the Parties to take a decision on the appropriate level of the 2012-2014 Replenishment of the Multilateral Fund.

The TEAP established a Replenishment Task Force (RTF), co-chaired by Lambert Kuijpers and Shiqiu Zhang, to prepare the report. A draft report was reviewed by the Chief Officer of the MLF Secretariat and her staff as well as by an external Review Panel. After review and subsequent discussions, a final draft report was adopted by the TEAP on 12 May 2011.

## 2 Funding requirement and cost effectiveness

The funding requirement for the triennium 2012-2014 is presented for six funding scenarios as indicated in the table below.

| **Funded reductions from baseline** | **Funding requirement for triennium 2012-2014 for three levels of funded baseline reductions and two sub-sector reduction packages (foam-refrigeration/AC-servicing) (US$ million)** |
|---|---|
| Sub-sector reduction package 75-15-10% | |
| **10%** | **306.1** |
| **15%** | **481.3** |
| **20%** | **653.5** |
| Sub-sector reduction package 90-0-10% | |
| **10%** | **245.2** |
| **15%** | **386.1** |
| **20%** | **529.3** |

There are qualitative grounds for suggesting that the most likely funding outcome, comprising funding for both consumption reduction and production closure, could lie in the mid-range of the scenarios presented. **For instance, the average of the scenarios above with a 10% spread would be US$ 390.2-477.0 million for the triennium 2012-2014**.

The indicative funding ranges for the succeeding two triennia are US$ 572.9 – US$ 686.6 million for the triennium 2015-2017 and US$ 611.4-US$ 776.1 million for the triennium 2018-2020.

For the period 2015-2017, a funded reduction in consumption of a further 15% has been considered, together with two similar reduction packages consisting of 75% foam, 15% RAC manufacturing and 10% servicing, and

90% foam with 10% servicing respectively. In the triennium 2018-2020, a funded reduction of 16.5 percent is required. The same two subsector reduction packages have been considered.

The average funding level of all scenarios across the three triennia is US$ 587.8 million per triennium, equivalent to total funding of US$ 1,763 million (about US$ 1.8 billion) for the period 2012-2020.

## 3 Method of assessment

The total funding requirement is the sum of the following cost elements:

- approved forward commitments from approved investment projects in the consumption sector, including individual HCFC phase-out projects and stage I HPMPs approved prior to 2011
- new stage I HPMPs, determined via a spreadsheet analysis by the Task Force that has at its core:
    - a country–by –country assessment using 'reduction packages' to achieve the reductions in consumption that should be funded in the first triennium
    - cost-effectiveness values for each sub-sector in a reduction package determined on the basis of an evaluation of available and likely technologies, an assessment of the percentage of HCFC-22 likely to be used for servicing, the current funding rules and policies of the Executive Committee and evidence from recently approved projects
- broad estimates for possible new closure projects in the production sector mainly for HCFC-141b and -142b, based upon the consumption reduction estimates
- supporting activities, including costs for the CAP programme, Core Unit funding for the Implementing Agencies, operating costs of the MLF Secretariat and Executive Committee and the costs for the Treasurer based on historical costs and continuation of current activity levels.

The funding requirement has been calculated for the four-year period 2011-2014. It takes into account the funds approved at the Executive Committee's 63rd Meeting. The funding estimate for the triennium is obtained by subtracting from the four-year figure the balance of funding available for expenditure in 2011in the Consolidated Business Plan (US$ 252.7 million), or, after the 65th Meeting, the total expenditure approved in 2011. The components of the four-year estimate for each of the six scenarios developed appear in the following table.

| Reduc-tion from baseline | Assessed costs for the 4-year period 2011-2014 | | | | | Planned funding available for the balance of 2011 | **Funding requirmt for the triennium 2012-2014 for each scenario** |
|---|---|---|---|---|---|---|---|
| | New HPMPs | Production Closure HCFC-141b/-142b | Production Closure HCFC-22 | | | | |
| | **Sub-sector reduction package 75-15-10% (foam-refr/AC-servicing)** | | | | | | |
| **10%** | 240.7 | 65.0 | 57.6 | | | | |
| **15%** | 354.6 | 97.0 | 84.2 | | | | |
| **20%** | 471.3 | 129.0 | 110.7 | 195.2 | 906.2 | (252.7) | **653.5** |
| | **Sub-sector reduction package 90-0-10% (foam-refr/AC-servicing)** | | | | | | |
| **10%** | 190.3 | 77.7 | 34.7 | 195.2 | 497.9 | (252.7) | **245.2** |
| **15%** | 277.9 | 116.0 | 49.7 | 195.2 | 638.8 | (252.7) | **386.1** |
| **20%** | 367.6 | 154.4 | 64.8 | 195.2 | 782 | (252.7) | **529.3** |

The triennium funding requirement is very much dependent on the eventual HCFC production plant closure funds that might be approved and disbursed within the triennium. Production closure costs for each of the six scenarios range from 38 percent to 46 percent of the total funding requirement. While HCFC consumption phase-out costs were analysed in detail using a mathematical model, the Task Force had little policy guidance or data on which to base a production sector analysis and accordingly based production sector estimates on the provision of funding for reductions in levels of production pro-rata with levels of consumption and at a cost comparable with CFC production closure.

## 4 HPMPs and MLF Business planning

Article 5 Parties are being assisted to phase out HCFC consumption by means of an HCFC phase-out management plan (HPMP) which sets out a coordinated national approach to HCFC phase-out including national policy and regulatory measures, technical assistance and assistance for phase-out in industrial processes in all consumption sectors. Stage I of an HPMP addresses, as a minimum, achievement of the baseline freeze for HCFCs in 2013 and the 10 per cent reduction in 2015. The funding estimate for the first triennium has been based on stage I HPMPs. Indicative funding estimates for the second and third triennia are based on further stages of HPMPs under similar funding conditions.

Explicit funding policies adopted by the Executive Committee to implement the HPMP concept such as cost-effectiveness thresholds and levels of assistance for LVC countries have been applied in the spreadsheet analysis. Policy trends evident from the structure and funding levels of projects and

HPMPs so far approved and from the Fund's business planning process have been assessed in developing the funding scenarios and reduction packages.

## 5 HCFC consumption and production levels

Total HCFC consumption in Article 5 countries in 2009 was some 33,500 ODP tonnes. Of this total some 33,418 ODP tonnes consisted of HCFC-141b, HCFC-142b and HCFC-22. To achieve the 10 percent reduction step by 2015 it will be necessary to address principally the sub-sectors in which these HCFCs are used, namely, PU foam, XPS foam, refrigeration, air conditioning and, possibly, solvents.

HCFC-141b and HCFC-142b are produced in only one Article 5 country, often in the same plant; however, HCFC-141b is also produced in specific HCFC-141b plants. HCFC-142b is also used as a feedstock. There may be options for diversion of additional quantities of HCFC-141b for feedstock uses but the opportunities remain speculative at this stage. Funding requirements have been based on plant closure and consumption phase-out quantities.

In 2009, total production of HCFC-22 in 6 Article 5 countries was 20,800 ODP tonnes, some 80 percent of which took place in a single Article 5 country that was also the only net exporter. There are significant opportunities for diversion of consumption for feedstock use.

## 6 HCFC phase-out costs

The funding requirement for the phase-out of HCFCs was determined on the basis of:

- estimated costs for the required HCFC consumption phase-down in the larger consuming Article 5 countries (groups 1 and 2)
- actual costs for already approved individual HCFC projects and stage I HPMPs in larger-consuming Article 5 countries
- estimated costs for the HCFC phase-down in the production sector
- estimated costs for the HCFC phase-down in the servicing sector, in fact, HPMPs for countries with a consumption generally smaller than 360 tonnes of HCFC-22 (including few exceptions where consumption is greater than 360 tonnes and use is still confined to the servicing sector only
- actual costs for the HCFC phase-down in the servicing sector in LVC countries via already approved HPMPs, with funding commitments in tranches, the last one being in 2020).

### *6.1 Methodology for HCFC consumption phase-out*

The characteristics of HCFC phase-out activities in Article 5 countries, and thus their cost, vary significantly according to the level of HCFC consumption. Accordingly the Task Force divided Article 5 countries into four consumption groups as indicated in the table below.

***Article 7 HCFC consumption for 2005-09 in ODP tonnes aggregated for four groups of Article 5 countries***

| | Number of countries in Group | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| **Group 1** | 1 | 11652 | 16078 | 17859 | 15387 | 18603 |
| **Group 2** | 33 | 7052 | 8343 | 10577 | 11247 | 12184 |
| **Group 3** | 25 | 289 | 364 | 372 | 522 | 795 |
| **Group 4** | 86 | 238 | 215 | 284 | 323 | 401 |

Funding requirements for each country in Groups 1 and 2 and certain countries in Group 3 were calculated separately using the spreadsheet analysis. The funding requirement for the balance of countries in Group 3 was calculated using a standard format and for Group 4 using the Executive Committee's specific funding guidelines for LVC countries.

Despite the large number of countries in Group 4 (LVCs), because of their low overall consumption, which is entirely in the servicing sector, the total estimated funding for Group 4 makes only a minor contribution to the overall funding requirement. Generally, this would be less than 10% of the total HCFC funding determined for the 2012-2014 triennium, independent of specific reduction scenarios.

### *6.2 Funding Scenarios*

Noting that the freeze on HCFC consumption does not come into force until 1 January 2013, the Task Force decided to calculate funding requirements for three different levels of HCFC phase-out funded in Stage I HPMPs for non-LVC countries, namely 10, 15 and 20 percent of the estimated baseline of the relevant country. These amounts are based on an examination of the levels of phase-out funded in stage I HPMPs already approved for non-LVC countries. They should not be confused with the reductions in consumption to be achieved through the HPMPs, which are generally confined to meeting the 2015, 10 percent reduction step.

HPMP project approvals by the Executive Committee to date have exhibited the following sectoral characteristics:

- consistent with the requirement to address higher ODP substances first, a preference for reductions in the foam sub-sectors, plus a certain portion of reductions in the refrigeration and air conditioning manufacturing, plus servicing, or
- reductions in the foam sub-sectors, plus reductions in the servicing sector.

The Task Force therefore selected two cases for the composition of 'reduction packages', firstly: 90% foam, 0% RAC manufacturing and 10% servicing, and secondly: 75% foam, 15% RAC manufacturing and 10% servicing. Together with the three options for funding of reductions from the baseline, this yielded six scenarios for HPMP funding.

### *6.3 HCFC Production phase-out*

Production phase-out of HCFC-22, HCFC-141b and -142b is assumed to occur in parallel with the consumption phase-out through separate plant closures. It is assumed to start in 2013, this being the first year with frozen or reduced production levels. A value of US$ 3.0 per kg of HCFC-141b and HCFC-142b phased out, consistent with costs for the CFC production sector closure, results in a total cost up to 2015 of between US$ 123 and US$ 240 million.

The production phase-out of HCFC-22 in Parties other than China will only have a small impact on production phase-out funding. Production in other countries takes place solely in swing plants that have already been funded for the closure of CFC production. No compensation for these plants has been included.

### *6.4 Technology options and cost effectiveness values*

Foam

The proven HCFC alternative options for foams include hydrocarbons, high GWP HFCs and carbon dioxide (water). The average cost-effectiveness values of HCFC conversion projects so far approved, based on the total project costs, are US$ 7.27/kg for polyurethane foam and US$ 2.56/kg for extruded polystyrene foam.

A primary challenge for the foam sector is the phase-out of HCFCs in the large number of small and medium size enterprises in Article 5 countries. In PU foam, hydrocarbons have been the preferred selected technology to replace HCFCs in large consuming companies, while saturated HFCs, $CO_2$ (water and supercritical) and methyl formate have been chosen for companies with lower consumption. Demonstration projects for all these technologies are in progress.

Refrigeration and Air Conditioning

HCFC-22, HCFC-123, HCFC-142b and HCFC-124 are HCFC refrigerants used in refrigeration and air conditioning applications, with HCFC-22 being by far the most important in Article 5 countries. The cost and the prospective market penetration of the full range of alternative refrigerants including hydrocarbons, high GWP blends, low GWP and unsaturated HFC blends have been examined. The cost effectiveness values for the commercial refrigeration and air conditioning sector were derived on the basis of penetration percentages of the different alternatives, considerations of incremental capital and operating costs, and possible maximum increases of 25% of the cost effectiveness for low-GWP conversions.

Separately, based on a potential penetration of low-GWP alternatives and the assessed cost-effectiveness values for relevant sub-sectors, a combination of cost-effectiveness values was made for refrigeration and air conditioning assuming certain HCFC-22 market percentages for commercial refrigeration and air conditioning.

The cost-effectiveness analysis in both sectors contains significant uncertainties. Values vary widely for different technology options within a particular sub-sector and for the same technology option in different sub-sectors. Best estimates have been used to determine the sub-sectoral values applied in the spreadsheet.

In general, the ab-initio assessments of cost-effectiveness exceed the limiting values specified in decision 60/44, particularly for some of the low-GWP options and in commercial refrigeration.

# 7 Concluding remarks

## *7.1 Triennium 2012-2014*

The lower funding requirement for the triennium 2012-2014 is due in part to the high level of funding remaining available in 2011 for stage I HPMPs. It also arises because funding levels in 2015-2017 and 2018-2020 are required to support increased reductions in HCFC consumption, namely 15 percent in the 2015-2017 triennium and 16.5 percent in the 2018-2020 triennium, compared to 10 percent in 2012-2014.

Three parameters have a significant impact on calculation of the triennium funding requirement. They are, in ascending importance: the share of the reductions attributed to the different technology sub-sectors in combination with cost-effectiveness values; the percentage reductions from the baseline funded in stage I HPMPs, and; the costs for production closure for all HCFCs (combined with estimates of when these funds would be disbursed).

Additionally, the level of consumption in China will result in China's HPMP and production sector plan having a significant influence on the overall funding requirements for the both the first and subsequent triennia. The Task Force has applied similar technical criteria in its analysis of HCFC funding scenarios for China and for the other larger consuming countries. No attempt has been made to assess possible outcomes arising from a negotiation process.

### *7.2 Stability of funding*

The funding requirements for the three trienna, spanning 2012 to 2020, show a clearly increasing trend, the third triennium exceeding the first by some US$ 250 million.

Several options could assist in re-balancing the funding requirements. An increase in the relevant subsector cost-effectiveness threshold values could facilitate the funding of an increased proportion of (more costly) low-GWP technologies. However in the short term the increased take-up of low-GWP solutions at the country level faces a number of practical challenges additional to the level of funding available.

Consideration could also be given to targeting higher levels of phase-out commitments in the first triennium in new Stage I HPMPs for non-LVC countries. While funded phase-out in approved HPMPs has exceeded 30 percent, phase-out commitments contained in them have more generally been confined to meeting the 10 percent reduction step by 2015. Consequent increases in funding requirements for the first triennium would be offset by a corresponding reduction in funding requirements in the second and/or third triennia. Most stage I HPMPs for larger consuming countries are already being prepared. Nonetheless, there could be benefits in examining options for increasing the phase-out targets contained in them. The funding of phase-out commitments of the order of 20 percent below the baseline could also introduce additional flexibility into the selection of reduction packages, in particular, opportunities to make available funding for fully justified increases in the proportion of low-GWP technologies included in a project. In this regard, although still speculative, an improvement in cost effectiveness over the next two triennia of around 20 percent would also make a significant contribution to supporting low-GWP options.

As already indicated, production closure funding has a significant influence on overall replenishment levels and on the distribution of funding allocations between triennia. Cost estimates are not at this stage based on specific policy guidance or technical analysis. The average funding level for the three triennia of US$ 588 million would decrease by US$ 75 million if the production closure costs were halved (using a value of US$ 1.5 per kg instead of the US$ 3.0 per kg used in this study).

The availability of additional information about the structure and organisation of the industry, especially with regard to feedstock uses, the production sector technical audit for China, and the development of additional guidance by the Executive Committee's Production Sector Working Group, would facilitate a more comprehensive examination of production sector funding requirements and enable refinement of triennia estimates.

The development and implementation of production closure projects (with funding expenditure) in the first triennium would appear to merit priority, both to support reductions in the consumption sector and to avoid greater imbalances in triennia funding requirements. It may be useful to consider a wider variety of production closure funding scenarios in future studies.

# 1 Introduction

## 1.1 Terms of Reference

Decision XXII/3 of the Twenty Second Meeting of the Parties requests, in its paragraph 1, the Technology and Economic Assessment Panel (TEAP) to prepare a report for submission to the Twenty-third Meeting of the Parties (Bali, Indonesia, November 2011), and present it through the Open-ended Working Group at its 31st meeting, to enable the Twenty-third Meeting of the Parties to take a decision on the appropriate level of the 2012-2014 Replenishment of the Multilateral Fund.

## 1.2 Scope and Coverage

The text of Decision XXII/3 is as follows:

1. To request the Technology and Economic Assessment Panel to prepare a report for submission to the Twenty-Third Meeting of the Parties, and to present it through the Open-ended Working Group at its thirty-first meeting, to enable the Twenty-Third Meeting of the Parties to take a decision on the appropriate level of the 2012–2014 replenishment of the Multilateral Fund;

2. That, in preparing the report referred to in the preceding paragraph, the Panel should take into account, among other things:

(a) All control measures and relevant decisions agreed upon by the parties to the Montreal Protocol and the Executive Committee, in particular those related to the special needs of low-volume- and very-low-volume-consuming countries, and decisions agreed upon by the Twenty-Second Meeting of the Parties and the Executive Committee at its sixty-first and sixty-second meetings insofar as those decisions will necessitate expenditure by the Multilateral Fund during the period 2012–2014;

(b) The need to allocate resources to enable all parties operating under paragraph 1 of Article 5 of the Montreal Protocol to maintain compliance with Articles 2A–2E, 2G and 2I of the Protocol;

(c) The need to allocate resources to enable all parties operating under paragraph 1 of Article 5 to meet 2013 and 2015 compliance obligations in respect of Articles 2F and 2H of the Protocol;

(d) Rules and guidelines agreed upon by the Executive Committee at all meetings, up to and including its sixty-second meeting, for determining eligibility for the funding of investment projects, non-investment projects, including institutional strengthening, measures to combat illegal trade and sectoral or national phase-out plans, including hydrochlorofluorocarbon phase-out management plans, measures to manage banks of ozone-depleting substances and ozone-depleting substance destruction projects;

(e) The impact that the international market, ozone-depleting substance control

measures and country phase-out activities are likely to have on the supply of and demand for ozone-depleting substances, the corresponding effects on the price of ozone-depleting substances and the resulting incremental costs of investment projects during the period under review;

3. That, in preparing the report referred to above, the Panel should consult widely all relevant persons and institutions and other relevant sources of information deemed useful;

4. That the Panel shall strive to complete the report referred to above in time to enable it to be distributed to all parties two months before the thirty-first meeting of the Open-ended Working Group;

5. That the Panel should provide indicative figures for the periods 2015–2017 and 2018-2020 to support a stable and sufficient level of funding, on the understanding that those figures will be updated in subsequent replenishment studies.

The Decision XXII/3 is directly related to Decision XIX/6 on Adjustments for Annex C, Group I substances (HCFCs), which mentions in several of its paragraphs:

*"The Parties agree to accelerate the phase-out of production and consumption of hydrochlorofluorocarbons (HCFCs), by way of an adjustment in accordance with paragraph 9 of Article 2 of the Montreal Protocol and as contained in the annex to the present decision, on the basis of the following:*

1. *For Parties operating under paragraph 1 of Article 5 of the Protocol (Article 5 Parties), to choose as the baseline the average of the 2009 and 2010 levels of, respectively, consumption and production; and*
2. *To freeze, at that baseline level, consumption and production in 2013;*
3. *For Parties operating under Article 2 of the Protocol (Article 2 Parties) to have completed the accelerated phase-out of production and consumption in 2020, on the basis of the following reduction steps:*

*(a) By 2010 of 75 per cent;*
*(b) By 2015 of 90 per cent;*
*(c) While allowing 0.5 per cent for servicing during the period 2020–2030;*

4. *For Article 5 Parties to have completed the accelerated phase-out of production and consumption in 2030, on the basis of the following reduction steps:*

*(a) By 2015 of 10 per cent;*
*(b) By 2020 of 35 per cent;*
*(c) By 2025 of 67.5 per cent;*
*(d) While allowing for servicing an annual average of 2.5 per cent during the period 2030–2040;*

5. *To agree that the funding available through the Multilateral Fund for the Implementation of the Montreal Protocol in the upcoming replenishments shall be stable and sufficient to meet all agreed incremental costs to enable Article 5 Parties to comply with the accelerated phase-out schedule both for production and consumption*

*sectors as set out above, and based on that understanding, to also direct the Executive Committee of the Multilateral Fund to make the necessary changes to the eligibility criteria related to the post-1995 facilities and second conversions;*

6. *To direct the Executive Committee, in providing technical and financial assistance, to pay particular attention to Article 5 Parties with low volume and very low volume consumption of HCFCs;*
7. *To direct the Executive Committee to assist Parties in preparing their phase-out management plans for an accelerated HCFC phase-out;*
8. *To encourage Parties to promote the selection of alternatives to HCFCs that minimize environmental impacts, in particular impacts on climate, as well as meeting other health, safety and economic considerations;*

9. *To agree that the Executive Committee, when developing and applying funding criteria for projects and programmes, and taking into account paragraph 6, give priority to cost-effective projects and programmes which focus on, inter alia:*

*(i) Phasing-out first those HCFCs with higher ozone-depleting potential, taking into account national circumstances;*
*(ii) Substitutes and alternatives that minimize other impacts on the environment, including on the climate, taking into account global-warming potential, energy use and other relevant factors;*
*(iii) Small and medium-size enterprises."*

The report was prepared on the basis of the Terms of Reference cited above.

The first draft of the report was discussed via e-mail contacts; a second draft report was subsequently discussed in an RTF- meeting during ExCom-63. A semi-final draft was composed for discussions by the RTF Review Panel and during the (annual) TEAP meeting in May 2011.

## 1.3 Funding Requirement as Determined in the Report

By the end of 2010, the Task Force decided to calculate the funding requirement for the period 2011-2014. The funding requirement for the triennium 2012-2014 could then be calculated by subtracting the funds available as of the beginning of 2011.

By the end of 2010, the Task Force could take into account the HCFC approvals done during Executive Committee Meetings in 2010 (they are considered in the spreadsheet analysis described in various chapters of the report below). After the Executive Committee meeting in April 2011 (ExCom-63) the Task Force decided to also take into account the decisions on funding (this mainly concerned funding for certain HPMPs) as taken during that meeting. This report therefore considers the funding requirement determined on the basis of data available from approvals until the beginning of April 2011, i.e., the funding requirement for the period mid 2011-end 2014 for existing commitments, as well as for HPMPs estimated to be approved after ExCom-63. The latter funding requirement is estimated on the basis of a spreadsheet analysis for the separate Article 5 countries for which HCFC reductions still have to be approved.

## 1.4 Composition of the Task Force

The TEAP established a Replenishment Task Force (RTF) to prepare the report following Decision XXII/3. The composition of the Task Force is as follows:

- Lambert Kuijpers (The Netherlands, co-chair TEAP, co-chair RTOC);
- Shiqiu Zhang (China, senior expert member TEAP);
- Daniel Colbourne (UK, member RTOC)
- Sukumar Devotta (India, member RTOC)
- Katerina Gargalasis (Greece, consultant)
- Tony Hetherington (Australia, former UNMLFS);
- Fred J. Keller (USA, member RTOC);
- Erik Pedersen (Denmark, member HTOC);
- Roberto Peixoto (Brazil, co-chair RTOC);
- Miguel Quintero (Colombia, co-chair FTOC).

The Replenishment Task Force was co-chaired by Lambert Kuijpers and Shiqiu Zhang.

An external review of the final draft report was conducted by the Chief Officer of the MLF Secretariat Maria Nolan and her staff, as well as by the Executive Secretary of the Ozone Secretariat and his staff.

A Review Panel consisting of Patrick McInerney (ExCom chair 2011), Javier E. Camargo (ExCom chair 2010), Stephen O. Andersen and Marta Pizano (TEAP co-chairs) and Romina Picolotti (Argentina) also reviewed the final draft report.

A semi-final draft of the report was discussed by the TEAP during its meeting in Geneva, Switzerland, 8-12 May 2011. Suggestions for the finalisation of the report were given and a final draft was circulated by email to the Replenishment Task Force and the TEAP for endorsement.

## 1.5 Consultation Process

The consultation process began in September 2010 with a meeting between a co-chair of the RTF and staff of the MLF Secretariat. The meeting addressed experiences and estimations of the Secretariat regarding the validity of assumptions to be used to estimate funding requirements for the HCFC phase-down as decided in Decision XXII/3.

In January 2011, the RTF sent 62 requests for information to Article 5 and non-Article 5 Parties, as well as to the Implementing Agencies. The RTF received a number of responses from several non-Article 5 Parties and one short communication from an Article 5 Party. The complete texts of the responses are given in Annex 2 to this report. Implementing Agencies responded by email and via attachment to emails to specific requests by the Task Force.

At the 63th meeting of the Executive Committee in April 2011, several Parties, representing both Article 5 and Non-Article 5 Parties, as well as members of the Multilateral Fund Secretariat were further consulted by RTF members in order to get further information on several issues related to HCFC phase-out strategies.

## 1.6 The Structure of the 2012-2014 Replenishment Report

The structure of the 2011 TEAP Replenishment Task Force Report is as follows:

The Executive Summary is presented first in this report, with separate parts referring to the separate chapters.

Chapter 1, "Introduction", presents the Terms of Reference, establishment of the Task Force and the consultative processes used to prepare this report.

Chapter 2, "Comparison of the Previous Replenishment Estimate with 2009-2011 Outcomes" describes the previous replenishments of the Multilateral Fund, looks back at the funding assessments made in the 2009-2011 replenishment report, and compares these with the funding for projects and phase-out plans that were approved in 2009 and 2010 and are contained in the 2011 endorsed Consolidated Business Plan.

Chapter 3, "HCFC Consumption and Production", describes the global, non-Article 5 and Article 5 patterns in HCFC consumption and production. It describes four different groups of Article 5 countries on the basis of their consumption. It also mentions specific consumption and production aspects for these groups of Article 5 countries.

Chapter 4, "HCFC Phase-out Management Plans (HPMPs) and Multilateral Fund Business Planning" outlines the Executive Committee's policies and rules for funding HCFC phase-out activities and looks at Multilateral Fund business planning as of the 62nd-63rd Executive Committee meeting for the period 2011-2014.

Chapter 5, "Cost Effectiveness Considerations" describes the development of cost effectiveness values for foams (both PUR and XPS) and for refrigeration and air conditioning. These cost effectiveness values have been used when making estimates for the costs of stage I HPMPs still to be approved, and for calculating the indicative funding amounts for the funding requirement for the triennia beyond 2014.

Chapter 6, "Methodology" describes the approach how to address the different types of countries where it concerns HCFC phase-down to 2015 or 2020, elaborates on the parameters used. It describes the various scenarios applied in the calculations where it concerns consumption reduction by 2015 and how reductions are assumed to be approved in the various sub-sectors (foam, refrigeration and AC manufacturing and servicing).

Chapter 7, "The Funding Requirements for ODS Phase-out Commitments and for Supporting Activities for the 2012-2014 Replenishment Period and Beyond" gives the funding requirement for the ODS phase-out commitments, Institutional Strengthening,

ODS destruction and technical assistance for the period 2011-2014 as well as the funding requirement for the supporting activities including Core Unit costs, costs for the Compliance Assistance Programme (CAP), the Secretariat and the Executive Committee, as well as for the Treasurer for 2011-2014 (and for the two triennia beyond). It includes the impact of funding decided at ExCom-63.

Chapter 8, "Total Funding Requirement" presents the total funding requirement for the replenishment of the Multilateral Fund for the triennium 2012-2014. This is done for the different scenarios presented in chapter 6. It also presents indicative numbers for the funding requirements for the triennia 2015-2017 and 2018-2020 for a scenario with a specific reduction composition for the sub-sectors in the reduction total.

Chapter 9 presents "Concluding Remarks", i.e., comments and qualifications on the methodologies, assumptions, data and other factors used to develop the funding requirement for the 2012-2014 replenishment and for the triennia beyond.

# 2 Comparison of the Previous Replenishment Estimate with 2009-2011 Outcomes

## 2.1 Achievements to date

The Multilateral Fund has been replenished six times since its initial capitalisation of US$ 200 million for the period 1991-1993. The replenishments were as indicated below (with the amounts decided including the carry-over in brackets):

- 1994-1996 US$ 455 million (US$ 510 million);
- 1997-1999 US$ 466 million (US$ 540 million);
- 2000-2002 US$ 440 million (US$ 475.7 million);
- 2003-2005 US$ 474 million (US$ 573 million);
- 2006-2008 US$ 400.4 million (US$ 470 million);
- 2009-2011 US$ 400 million (US$ 490 million).

Since its inception, the Multilateral Fund has supported some 145 Article 5 Parties by providing US$ 2.7 billion in project funding and capacity building to phase-out of 247,574 ODP tonnes in consumption and 185,026 ODP tonnes in production of ODSs

The Montreal Protocol has witnessed unparalleled participation as evidenced by the fact that all UN member states are parties to it, and to several of its amendments. The Multilateral Fund has played a major role in securing Article 5 participation and aiding their success. Both non-Article 5 and Article 5 Parties have actively participated to realise the Fund's objectives. The total income of the Fund stands at US$ 2.7 billion as of April 2011.

Key achievements are:

- contributions to the Multilateral Fund amount to about 95% of pledges, up to the end of 2010
- all decisions by the Executive Committee have been taken by consensus;
- 148 Article 5 Parties have received financial assistance
- 144 National Ozone Units have been established and are receiving funding
- 9 Regional / Sub-regional Networks encompassing all Article 5 Parties have been established
- financial assistance has been provided to phase-out 100 percent of the CFC baseline consumption
- financial assistance has been provided to phase-out about 98% of the MB baseline consumption
- a majority of Parties has served as members or co-opted members of the Executive Committee

- in addition to the activities of the four Implementing Agencies, many projects have been carried out with the assistance of national Implementing Agencies through bilateral co-operation

In regard to HCFCs:

- detailed policy guidance has been developed for the approval of financial assistance to phase out HCFCs including equipment cut off dates, second stage conversions and cost effectiveness for capital and operating costs for relevant subsectors
- as of April 2011:

  133 Article 5 Parties have received financial assistance for the preparation of stage 1 HPMPs to meet the 2013 and 2015 Protocol control measures for HCFCs;

  60 Article 5 Parties have received approval and funding for implementation of stage 1 HPMPs, of which 14 are non-LVC Parties; of these, 10 HPMPs for LVC countries will achieve all HCFC commitments plus full phase-out in 2030.

  38 HPMPs have commitments to meet the 2020 control measures and the remaining 12 will meet the 2015, 10 percent reduction step;
- 12 countries have received investment projects in advance of submission of an HPMP. Nine of these projects will result in phase-out greater than required for the 2015, 10 percent reduction step. Most were large and very cost-effective projects in the foam sector.

## 2.2 Funding comparison

The table below presents the estimates for the funding requirements developed in the 2008 Replenishment Task Force report /UNEP08/ and compares them with the actual and projected levels of approved Multilateral Fund commitments entered into for the years 2009-2011, (referred to in the table as 'expenditure'). The projected expenditure is based on actual funding approved by the Executive Committee for the years 2009 and 2010 and the expenditure for 2011 proposed in the consolidated 2011 business plans of the Fund endorsed by the Executive Committee at its 63rd Meeting in April 2011.

For the first time, this comparison has been able to benefit from information concerning actual expenditure for HCFC activities. This information is all the more significant since most HCFC phase-out activities have been presented in the form of HCFC phase-out plans with expenditure approved in-principle, generally up to and including the year 2016. The HCFC phase-out plans are themselves based on decisions taken by the Executive Committee on the eligibility of activities associated with HCFC phase-out (both investment and non-investment activities) and on the acceptable level of cost-effectiveness of these activities.

Differences between RTF 08 estimates and anticipated 2008-2011 expenditure in the more significant expenditure categories are discussed in the following sections.

### *ODS consumption (non-HCFC)*

Actual expenditure was some US$ 12 million (18 percent) lower than the 2008 estimate. Delays in submission of some NPP tranches and lower than expected project funding levels for the remaining NPPs and for methyl bromide projects approved during the triennium are the likely main contributors.

| **Funding requirement**<br>**US$ million**<br><br>**Activities** | **2009-2011 estimate from 2008 RTF report** | **2009-2011 Expenditure (2009-2010 actuals plus 2011 business plan)** |
|---|---|---|
| ODS Consumption (Non-HCFC) | 64.58 | 51.986 |
| ODS Production (Non-HCFC) | 19.108 | 18.077 |
| HCFC Preparatory Activities | 7.72 | 11.506 |
| HCFC Consumption Phase-out (HPMPs and Demonstration Projects) | 130.88-427.88 | 276.971 |
| HCFC Production | 0 | 0.057 |
| Destruction | 27.000 | 11.198 |
| Supporting activities* | 91.995 | 90.8 |
| | | |
| **TOTAL** | **342.83-639.83** | **460.6** |

**Note*** Includes *Institutional Strengthening, Technical Assistance, UNEP's CAP, Implementing Agency Core Unit Costs, ExCom meetings, costs for the Secretariat and Treasurer*

Differences between the estimates in /UNEP08/ and anticipated 2008-2011 expenditure in the more significant expenditure categories are discussed in the following sections.

### *ODS consumption (non-HCFC)*

Actual expenditure was some US$ 12 million (18 percent) lower than the 2008 estimate. Delays in submission of some NPP tranches and lower than expected project funding levels for the remaining NPPs and for methyl bromide projects approved during the triennium are the likely main contributors.

### *ODS production (non-HCFC)*

The anticipated expenditure is within US$ 1 million (5 percent) of the estimate, reflecting the fact that almost all production sector phase-out projects had been approved at the time of preparation of the previous report.

### *HCFC preparatory activities*

Concurrently with development by the Executive Committee of key HCFC funding policies, most notably indicated by decision 60/44 taken in March 2010, the implementing agencies made rapid progress in late 2009 and through 2010 with development of funding proposals to prepare HPMPs and stand alone HCFC demonstration or phase-out projects for larger consuming countries.

The Executive Committee adopted a staged approach to HCFC funding policy whereby the broad framework for phase-out activities, including the HPMP concept, was decided early and detailed rules were subsequently agreed over an extended period. This appears to have facilitated the work of the implementing agencies in working with Article 5 partners to achieve speedy development of funding requests for project preparation activities, mainly HPMPs. The result of this activity was that project preparation expenditure exceeded the 2008 estimate by some 50 percent or US$ 3.8 million.

Given that these preparatory activities have already resulted in submission and approval of 60 HPMPs, the approach adopted by the Executive Committee and implementing agencies appears to have achieved a very favorable outcome, in view of the short time prior to commencement of the freeze on 1 January 2013.

### *HCFC consumption phase-out activities*

At the time of preparation of the RTF report in 2008 /UNEP08/, the latest HCFC consumption and production data reported under Article 7 was for the year 2006. Estimates of consumption for the succeeding three years, during which the use of HCFCs in Article 5 countries for the production of foam and in the manufacture of equipment for refrigeration and air conditioning was expanding rapidly, were speculative. Additionally, the Executive Committee's rules and policies for funding the phase-out of HCFCs were in the earliest stages of development, the initial decision on the framework of HCFCs having only been taken at the Committee's 54th Meeting in April 2008. These key factors led to a wide range of cost estimates for possible Multilateral Fund expenditure for the period 2009-2011. Nonetheless, estimated actual triennium expenditure for the phase-out of HCFCs triennium falls at the mid-range of the original RTF 08 estimate, indicating the broad validity of the upper and lower bounds of the estimate.

The RTF also notes that the under the Consolidated Business Plan of the Fund for 2011, the Executive Committee envisages total funding for HCFC projects and activities (including project preparation) of some US$ 207 million and a total funding level for all activities of some US$ 260 million. If realized, this would represent the highest level of annual expenditure since the inception of the Fund. Given that in previous years the Committee has accepted 'over-programming' of around 30 percent in annual business plans, there some scope for final HCFC expenditure figures to be up to 25 percent lower than the business plan figure, amounting to a difference of

some US$ 52 million. In this event, total triennium expenditure for HCFC phase-out would be around US$ 230 million, in the lower mid-range of the 2008 estimate.

***Destruction***

The development of funding options for disposal and destruction of ODS has been the subject of protracted discussions at both Meetings of the Parties and in the Executive Committee. Indeed, Committee discussions on policy issues are ongoing. The triennium estimate of actual expenditure on destruction relates almost entirely to the inclusion of proposed projects and activities in the 2011 business plan. Projects are likely to be subject to consideration on a case-by-case basis when they are presented for approval during 2011. Accordingly, the progress towards substantial expenditure on destruction activities has been much slower than was envisaged in the RTF report.

## 2.3 Concluding Observations

The RTF report in 2008 /UNEP08/ was prepared in the absence of sound data on HCFC consumption trends and on the cost structure of projects for HCFC phase-out. This necessitated a broad range of costs for HCFC projects and activities. Current estimates indicate actual expenditure for the 2009-2011 triennium falling at the mid-point of the RTF estimate. Actual HCFC-based expenditure may be somewhat lower than indicated in 2011 business plans, in which case the total for the triennium would fall into the lower mid-range category.

Non-HCFC expenditure was broadly consistent with estimates, since many of the costs were either standard in nature or were already subject to approval-in-principle. The exception was lower expenditure on destruction activities, for which the policy development process proved to be more drawn-out than envisaged.

The conclusion by the Executive Committee of most of the rules and policies necessary for costing HCFC phase-out has provided a basis for more detailed and, prospectively, more accurately targeted cost estimates for the coming triennia. As well, HCFC consumption data estimates are now only needed for one year, namely, 2010, to establish the baseline for HCFC control measures. As presented in the succeeding chapters of this report, the availability of this additional information has enabled more detailed analysis and potentially a narrower range of cost estimates on which to base the 2012-2014 and later triennia funding requirements, at least for the consumption sector.

# 3 HCFC Production and Consumption

## 3.1 The Various HCFC Chemicals Used in Article 5 Countries

According to Article 7 data reporting to UNEP's Ozone Secretariat, Article 5 countries consume 8 different HCFCs. Consumption in metric tonnes and in ODP-tonnes for the years 2006-2009 are given in Table 3-1. The data used for Table 3-1 and subsequent tables in this chapter are from February 2011.

| Number | | Substance | ODP | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|
| 81 countries | TOTAL in tonnes | HCFC-141b | 0.11 | 83577 | 93560 | 94310 | 103487 |
| | **TOTAL in ODP tonnes** | **HCFC-141b** | **0.11** | **9193** | **10292** | **10374** | **11384** |
| | | | | | | | |
| 56 countries | TOTAL in tonnes | HCFC-142b | 0.065 | 29313 | 28893 | 26822 | 33899 |
| | **TOTAL in ODP tonnes** | **HCFC-142b** | **0.065** | **1905** | **1878** | **1743** | **2203** |
| | | | | | | | |
| 147 countries | TOTAL in tonnes | HCFC-22 | 0.055 | 294264 | 354243 | 328294 | 378746 |
| | **TOTAL in ODP tonnes** | **HCFC-22** | **0.055** | **16185** | **19483** | **18056** | **20831** |
| | | | | | | | |
| 53 countries | TOTAL in tonnes | HCFC-123 | 0.02 | 2156 | 2048 | 1979 | 2168 |
| | **TOTAL in ODP tonnes** | **HCFC-123** | | **43** | **41** | **40** | **43** |
| | | | | | | | |
| 40 countries | TOTAL in tonnes | HCFC-124 | 0.022 | 823 | 963 | 317 | 1490 |
| | **TOTAL in ODP tonnes** | **HCFC-124** | **0.022** | **18** | **21** | **7** | **33** |
| | | | | | | | |
| 12 countries | TOTAL in tonnes | HCFC-225 | 0.07 | 369 | 57 | 104 | 55 |
| | **TOTAL in ODP tonnes** | **HCFC-225** | **0.07** | **26** | **4** | **7** | **4** |
| | | | | | | | |
| 8 countries | TOTAL in tonnes | HCFC-225ca | 0.025 | 82 | 65 | 93 | 58 |
| | **TOTAL in ODP tonnes** | **HCFC-225ca** | **0.025** | **2** | **2** | **2** | **1** |
| | | | | | | | |
| 4 countries | TOTAL in tonnes | HCFC-225cb | 0.033 | 116 | 60 | 8 | 19 |
| | **TOTAL in ODP tonnes** | **HCFC-225cb** | **0.033** | **4** | **2** | **0** | **1** |

***Table 3-1 Various HCFC chemicals used in Article 5 countries (the number of countries that report consumption of the different HCFCs are given in the first column) in tonnes and ODP-tonnes for the years 2006-2009***

*Note: the countries include the Republic of Korea, Singapore and the United Arab Emirates*

For the aggregated reduction in HCFC consumption it is important to analyse the relative importance of the consumption of the various HCFCs in ODP tonnes. Of a total consumption of about 33,500 ODP tonnes in the year 2009, 82 ODP tonnes consist of the consumption of HCFC-123, HCFC-124 and the various isomers of HCFC-225, which is less than 0.3 percent.

This implies that for a reduction percentage of 10%, as applies for the period 2013 to 2015, HCFC consumption reductions have to be realised in the sub-sectors that use HCFC-141b, HCFC-142b and HCFC-22, this in fact being the foam, XPS foam, refrigeration, air conditioning manufacturing and solvent sub-sectors, as well as the HCFC-22 servicing sector for refrigeration and air conditioning.

## 3.2 HCFC Data

This section discusses non-Article 5, Article 5 and global production and consumption of the three important HCFC chemicals: HCFC-141b, HCFC-142b and HCFC-22.

***Table 3-2 HCFC-141b Non-Article 5, Article 5 and global production and consumption numbers for 1995, 2000 and 2005-2009 (Article 7 reporting, UNEP, February 2011)***

| Year (tonnes) | | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|
| **Production-141b** | | | | | | | | |
| NA5 | | 111319 | 128385 | 11837 | 9777 | 7318 | 15746 | 10443 |
| A5 | | 0 | 11975 | 46794 | 74785 | 86837 | 81298 | 91880 |
| Global | | 111319 | 140360 | 58631 | 84562 | 94155 | 97044 | 102323 |
| **Consumption–141b** | | | | | | | | |
| NA5 | | 105350 | 113724 | 5455 | 9325 | 8362 | 10694 | 7308 |
| A5 | | 5629 | 38210 | 61412 | 83577 | 93560 | 94310 | 103487 |
| Global | | 110979 | 151934 | 66867 | 92902 | 101923 | 105004 | 110795 |

### *3.2.1 HCFC-141b*

#### *HCFC-141b Production*

The production of HCFC-141b was increased sharply in the 1990s in non-Article 5 countries, then reached a maximum of about 130,000 tonnes around 2000, and decreased again to 10,000 tonnes in the year 2009.

In Article 5 Parties the production was low until the turn of the century, then started to increase from about 12,000 tonnes in the year 2000 to 92,000 tonnes in the year 2009; this was almost a continuous increase (in these figures the Republic of Korea is included; however, the Republic stopped production of HCFC-141b as of 2005-2006).

Production of HCFC-141b takes place in non-Article 5 countries (US, Japan and France) and one Article 5 country (China). The Article 5 production constitutes around 85% of the global production. The HCFC-141b production in Non-Article 5 countries is for export only. In addition, China is exporting around 30-35% of its HCFC-141b production to other Article 5 countries. As can be seen in Table 3-2, there has been a steady increase in HCFC-141b production in Article 5 countries since 2005, except for the 2008 when the global economic crisis impacted demand. A small amount of HCFC-141b is used for feedstock for the production of HCFC-142b (in China).

#### *HCFC-141b Consumption*

The consumption of HCFC-141b increased sharply in the 1990s in non-Article 5 countries, then reached a maximum of about 120,000 tonnes around

2000, and decreased again to 7,500 tonnes in the year 2009. In Article 5 Parties the consumption was low until 1994-1995, then started to increase from about 5,000 tonnes in the year 1995 to about 104,000 tonnes in the year 2009; this was almost a continuous increase (in these figures the Republic of Korea is included).

***HCFC-141b Production versus Consumption***

Both production and consumption in Article 5 Parties are significantly larger than in Non-Article 5 Parties (where both production and consumption have decreased by more than a factor 10 over the period 2000-2009). Consumption in Non-Article 5 Parties has been smaller than production over the years, the difference varying between 400 and 5,000 tonnes during the period 2005-2009, which can be explained by exports to certain Article 5 Parties. Consumption in Article 5 Parties has been systematically larger than production, by about 7,000-12,000 tonnes during 2006-2009 (and even more before 2006). This cannot be made up for by exports of HCFC-141b (as mentioned before for HCFC-22). The result is that one can observe a systematic higher global consumption of about 8,000 tonnes of HCFC-141b over all years. This cannot be explained by stockpile effects. However, a systematic over-reporting of a constant value also seems awkward, even with strongly varying production and consumption numbers in both types of Parties. The issue of preblended polyols may be part of the explanation here; there may be double reporting of the amount in pre-blended polyols. This could happen via consumption reporting from the countries where the pre-blending takes place and from the Article 5 countries use pre-blended polyols that report imports (and thus consumption).

### *3.2.2 HCFC-142b*

***Table 3-3 HCFC-142b Non-Article 5, Article 5 and global production and consumption numbers for 1995, 2000 and 2005-2009 (Article 7 reporting, UNEP, February 2011)***

| Year (tonnes) | | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|
| **Production-142b** | | | | | | | | |
| NA5 | | 44642 | 39697 | 23297 | 26557 | 27790 | 31313 | 6033 |
| A5 | | 0 | 577 | 6125 | 21932 | 22994 | 22724 | 24890 |
| Global | | 44642 | 40274 | 29422 | 48489 | 50784 | 54037 | 30923 |
| **Consumption-142b** | | | | | | | | |
| NA5 | | 48838 | 34435 | 17945 | 18036 | 12010 | 16044 | 16600 |
| A5 | | 257 | 1638 | 9027 | 29313 | 28893 | 26822 | 33899 |
| Global | | 49095 | 36072 | 26972 | 47349 | 40903 | 42866 | 50499 |

***HCFC-142b Production***

The production of HCFC-142b was increased sharply in the 1990s in non-Article 5 countries, reached a maximum of about 40,000 tonnes around 2000, and then decreased to about 30,000 tonnes through 2008 with a sudden further decrease in the year 2009 to about 6,000 tonnes.

In Article 5 Parties the production was very low until 2003, then started to increase from about 4,000 tonnes in the year 2003 to 22,000 tonnes in the period 2006-2008; the reported production is about 25,000 tonnes in the year 2009 (in these figures the Republic of Korea is included; however, the Republic of Korea never produced much and stopped production of HCFC-142b as of 2005-2006).

Currently, production of HCFC-142b takes place in non-Article 5 countries (USA and EU member states) and in one Article 5 country (China). HCFC-142b is used in refrigerant blends and as a blowing agent for XPS foam. As can be observed in Table 3-3, aside from a significant increase from 2005 to 2006, there has been modest growth since 2006.

***HCFC-142b Consumption***

The consumption of HCFC-142b had a maximum around 50,000 tonnes in the 1990s in non-Article 5 countries, started to decline to about 35,000 tonnes around 2000, and then decreased to about 12,000 tonnes in 2008 with a sudden increase again of 4,000 tonnes to about 16,000 tonnes in 2008-09. In Article 5 Parties the consumption was very low until 2003, then started to increase from about 6,000 tonnes in the year 2003 to about 28,000 tonnes in the period 2006-2008; the reported consumption is about 34,000 tonnes for the year 2009 (in these figures the Republic of Korea is included).

***HCFC-142b Production versus Consumption***

Production in Article 5 Parties is smaller than in non-Article 5 Parties (where production has decreased from 40,000 to 6,000 during the last decade), but becomes much higher in 2009 due to an increase in Article 5 and a decrease in non-Article 5 production. Global production therefore peaks in 2007-2008, then decreases, where it is difficult to forecast which production level will be apparent in 2010-2012.

Consumption in Non-Article 5 Parties has always been smaller than production over the years, varying between 5,000 and 15,000 tonnes during the period 2000-2009, which can be explained by exports to certain Article 5 Parties.

Consumption in Article 5 Parties is systematically larger than production, by about 4,000-9,000 tonnes during 2006-2009. This could be made up for by exports of HCFC-142b from non-Article 5 Parties. Global consumption is more or less equal to production until 2007, the year 2007 then shows 10,000 tonnes higher production levels, followed by a 20,000 tonnes higher global consumption level in the year 2009.

Whereas global consumption (in particular Article 5 consumption) increased during recent years, global production decreased in the late 1990s, then

increased again up to 54,000 tonnes in the year 2008; it fell to 30,000 tonnes in the year 2009. Where there had been larger production than consumption up to the year 2008, the consumption reported for 2009 (50,000 tonnes) was 20,000 tonnes larger than production.

### *3.2.3 HCFC-22*

***HCFC-22 Production***

Due to controls on HCFC-22 in the European Union and the phase-out of the use of HCFC-22 in new equipment in the early 2000's, its production decreased from more than 200,000 tonnes in the 1990s to less than 75,000 tonnes in the year 2009 in non-Article 5 Parties. It is expected to further decrease in the year 2010 when servicing with virgin material will be prohibited in the EU and the U.S. will have a ban on the use of HCFC-22 for new equipment.

***Table 3-4 HCFC-22 Non-Article 5, Article 5 and global production and consumption numbers for 1995, 2000 and 2005-2009 (Article 7 reporting, UNEP, February 2011)***

| **Year (tonnes)** | | **1995** | **2000** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|---|---|
| **Production -22** | | | | | | | | |
| NA5 | | 295690 | 225119 | 160062 | 117281 | 140280 | 117621 | 74245 |
| A5 | | 32366 | 116606 | 272055 | 312686 | 360795 | 330078 | 371418 |
| Global | | 328056 | 341725 | 432116 | 429967 | 501075 | 447699 | 445663 |
| **Consumption -22** | | | | | | | | |
| NA5 | | 250595 | 175635 | 151909 | 137762 | 150975 | 139615 | 96072 |
| A5 | | 64018 | 156243 | 256607 | 294264 | 354243 | 328294 | 378746 |
| Global | | 314613 | 331880 | 408517 | 432026 | 505219 | 467908 | 474819 |

However, HCFC-22 production for uses controlled by the Montreal Protocol increased from roughly 25,000 tonnes in the early 1990s to more than 370,000 tonnes in the year 2009 in Article 5 Parties (of which the majority was produced in one Article 5 Party). This implies that global production has increased from less than 260,000 tonnes in the early 1990s to a level of about 450,000 tonnes in the year 2009. The production in Article 5 Parties has been larger than the production in non-Article 5 Parties as of the year 2003.

In addition to production controlled by the Montreal Protocol, HCFC-22 is produced for feedstock uses in both Non-Article 5 and Article 5 countries. HCFC production in the relevant Article 5 countries excluding China has been about 15-25% of the production of HCFC-22 in the largest producer, China. The total global HCFC-22 production was slightly lower than the reported consumption. Article 7 data indicate that only non-Article 5 countries and China are net exporters of HCFC-22.

***HCFC-22 Consumption***

Due to controls on HCFC-22 in the European Union and the phase-out of the use of HCFC-22 in new equipment, its consumption decreased from more than 200,000 tonnes in the 1990s to less than 100,000 tonnes in the year 2009 (this level is still quite high). Consumption is expected to further decrease in the year 2010 (see above, under production).

However, HCFC-22 consumption increased from roughly 20-40,000 tonnes in the early 1990s to more than 378,000 tonnes in the year 2009 in Article 5 Parties. Where it concerns HCFC-22, this chemical is reported under consumption by all Article 5 Parties, with largest consumption in one Party (China). This implies that global consumption has increased from less than 200,000 tonnes in the early 1990s to a value of about 475,000 tonnes in the year 2009. The consumption in Article 5 Parties is larger than the consumption in non-Article 5 Parties as of the year 2002. Compared to production values, differences can be explained by exports from non-Article 5 Parties to Article 5 Parties.

***HCFC-22 Production versus Consumption***

In Table 3-4 the growth of the HCFC-22 production and consumption in Article 5 Parties over the period 2005-2009 can clearly be observed; however, 2008 shows decreases related to economic influences on growth in Article 5 Parties, in particular in China.

Both production and consumption in Article 5 Parties are significantly larger than in non-Article 5 Parties (where both production and consumption are still very significant in the year 2009). Reporting of global consumption of HCFC-22 exceeds the reporting of global production by about 2-4,000 tonnes in the years 2005-2007, after larger production (than consumption) values reported in the years up to 2005, which may be due to errors in reporting. However, consumption exceeds production by 20,000 tonnes in 2008 and by 30,000 tonnes in 2009, for which it is difficult to find an explanation. Stockpiling (which is expensive) is unlikely to explain this effect, with 50,000 tonnes difference during the two years 2008 and 2009. Systematic over-reporting of consumption by particularly Article 5 Parties or mis-reporting of HCFC-22 consumption due to mistakes in dispersive and feedstock uses reporting may well be possible. However, the Task Force has no data to support either assumption and is not in a position to further investigate the issue.

## 3.3 Production and Consumption within various Article 5 Parties Groups

As required under Article 7, all Article 5 Parties reported the consumption of the various HCFC chemicals for the period 2005-2009. The Task Force decided to construct four groups of countries for the determination of the HCFC funding requirement based on the latest 2009 HCFC consumption, both aggregated and per chemical.

Only three HCFC chemicals (HCFC-22, -141b and -142b) are consumed in significant quantities.

The following four groups have been made:

1. Very high volume consuming countries (consumption in the order 300,000 tonnes); this is in fact one country, China;
2. Larger volume consuming countries with, normally, both HCFC-22 , -141b and 142b consumption (between 1,000 and 20,000 tonnes); in this group there are 33 Article 5 countries;
3. Smaller consuming countries which have, in most cases, consumption of HCFC-22 only (between 360 and 1,000 tonnes), but which have in several cases additional consumption of smaller quantities of HCFC-141b; in this group there are 25 countries;
4. "Low HCFC volume" consuming countries (in fact, all countries that consume volumes of HCFC-22 smaller than 360 tonnes); it concerns 86 countries.

### *3.3.1 HCFC Consumption from 2005 to 2009 in the Various Groups*

Consumption levels in many countries in Groups 1 and 2 have risen over the period 2007-2009 by 10-15% per year. In particular between 2008 and 2009 HCFC consumption has sharply increased --in some countries in certain regions--, by 50-500%, For instance some Parties reported values in the order of 8-30 tonnes over 2008, and 60 to 120 tonnes aggregated HCFC consumption in the year 2009. The largest increases often apply to the reporting of HCFC-22 consumption.

***Table 3-5 HCFC reported consumption for 2005-09 (Article 7 reporting, UNEP, February 2011) in aggregated form for the different groups of countries (number of countries given in second column), in ODP tonnes***

| Countries | Number | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| **Group 1** | 1 | 11652 | 16078 | 17859 | 15387 | 18603 |
| **Group 2** | 33 | 7052 | 8343 | 10577 | 11247 | 12184 |
| **Group 3** | 25 | 289 | 364 | 372 | 522 | 795 |
| **Group 4** | 86 | 238 | 215 | 284 | 323 | 401 |

Four of the top six countries in Group 2 report lower HCFC consumption for the year 2009 compared to the year 2008. In Group 2, with some exceptions where consumption decreases, virtually all consumption reported between 2008 and 2009 increases significantly for countries with a consumption lower than 500 tonnes; this results in a 10% increase for the Group 2 consumption as a whole.

Group 3 shows a smaller consumption per country, in many cases rather stable between 2008 and 2009, however, several Parties report 10-400% increases,

with others going from insignificant amounts to amounts in the order of 20-50 tonnes. Overall consumption increases by 50% between 2008 and 2009. To estimate baseline consumption, an 8% growth between 2009 and 2010 has been assumed in all cases.

Group 4 countries report relatively small consumption for the year 2008. In 2009 values increased in several cases by a large percentage, but in many cases small reductions were reported. Overall, a 25% increase between 2009 and 2008 was reported by Parties in Group 4.

### *3.3.2 HCFC Production from 2005 to 2009 in the Various Groups*

Only a small number of Article 5 Parties produce HCFCs. As one can take from Article 7 reported data the largest production takes place in the Group 1 country, China, and includes the three important HCFC chemicals, HCFC-141b, -142b and -22. HCFC-22 production is also taking place in four other Article 5 Parties, which are all in Group 2 (Argentina, India, Mexico and Venezuela). One manufacturer of HCFC-22 (Republic of Korea) has not been considered in this report since it has never requested MLF assistance.

Table 3-6 shows the amounts reported as produced during 2005-2009.

***Table 3-6 Production of the three main HCFCs in Group 1 and 2 Parties (Article 7 reporting, UNEP, February 2011) for the period 2005-2009 (metric tonnes)***

| Group and Chemical | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| **Group 1-HCFC-141b** | 43507 | 74385 | 86837 | 81298 | 91880 |
| **Group 1-HCFC-142b** | 5633 | 21844 | 22994 | 22724 | 24890 |
| **Group 1-HCFC-22** | 234718 | 263805 | 297677 | 263745 | 298559 |
| **Group 2-HCFC-22** | 37337 | 48881 | 63118 | 66333 | 72859 |

* The Republic of Korea has not been considered in this table. Over the years 2007-2009 the Republic of Korea reported zero production of the chemicals HCFC-141b and HCFC-142b

Total production of HCFC-22 in the Group 2 countries has been about 15-25% of the HCFC-22 production in Group 1 (China). The total amount of HCFC-22 produced in 2009 was slightly larger than 370,000 tonnes. Production of HCFC-22 in the year 2009 in the countries in the Groups 1 and 2 was smaller than the demand in all Article 5 Parties (see above).

Production of HCFC-141b and -142b took place in one Article 5 Party only and was sufficient to cover the domestic demand. This implies that both chemicals HCFC-141b and -142b have been imported from non-Article 5 Parties by virtually all (non-Group 1) Article 5 Parties with HCFC-141b and -142b consumption.

The Task Force has assumed that production will follow (will be largely equal to) the demand (assumed to be equal to consumption).

It is indicated in China's project documents that the production of HCFC-141b, -142b and -22 will be gradually phased out in China in the period as of 2013-2014, and that China will ask for (production) closure compensation funding. This might not be the case for the other Article 5 Parties that produce HCFC-22. Their HCFC production phase-out is in principle not eligible for funding, since it results from CFC swing plants that have already been funded for closure (conversion) on the basis of Agreements with the Executive Committee. The funding assumptions made by the Task Force for the calculations can be found in Chapter 6.

## 3.4 Some Specific HCFC Production Phase-out Issues

In accordance with the Montreal Protocol HCFC phase-out requirements, HCFC production in Article 5 countries will have to be reduced to the baseline in 2013 and to 90% of the baseline in 2015. As per the Protocol definition, production is defined as total HCFC production minus HCFC production used as feedstock minus the amount destroyed. As production includes HCFCs used for domestic consumption and for export, the production reductions in 2013 and 2015 will be supported by the HCFC consumption phase-out in Article 5 countries. Since it is not controlled by the Montreal Protocol, the possibility of increased levels of use as feedstock has some potential to absorb, at least in part, any excess production over consumptive needs.

The modality used to assess the eligible incremental costs for the CFC, CTC, TCA and halon production phase-out was based on the concept of lost profit. An estimate was made of the decrease in production between business as usual without the Montreal Protocol and the likely production level arising from the relevant phase-out schedule. This enabled assessment of profit per tonne of lost production based on actual costs and the expected remaining lifetime of the production facility. In order to determine the various parameters and confirm the baseline data the Executive Committee ensured, through an independent 'Techno-economic Audit', that the estimated cost was based on industrial norms and verified data. While the draft guidelines for the ODS production sector were never agreed by the Committee, they were used in most production sector projects approved to date to establish a starting point for negotiations between the producing country and the Committee.

There are different ways to look at the funding required for HCFC production closure compensation. One can, of course, look at the installed capacities in all Article 5 countries that produce, then look at the degree of utilisation of separate plants, and derive criteria to establish which plants might be closed as a result of lower production levels in the triennium 2012-2014 and the

triennia thereafter. For the largest producer country, i.e., China, the average degree of utilisation of production is of the order of 65% (total production for feedstock and dispersive uses divided by total capacity installed). However, plant information is not available to the Task Force. An alternative and simpler way would be to consider only the overall reductions in HCFC production required in 2013 and 2015 required to meet Protocol requirements. Relevant information for the three major HCFCs is provided below.

### *3.6.1 HCFC-22*

In evaluating the cost of HCFC-22 production phase-out, the possibility of diverting HCFC-22 production for controlled use to uses as feedstock may be considered. There is no evidence of a linkage between demand for HCFC-22 for controlled uses and for use as feedstock. Hence potential lost profit from a reduction in HCFC -22 production for controlled uses will be offset, provided there is an increasing market for feedstock.

Historically, HCFC-22 production for dispersive uses is normally larger than production for feedstock. However economic data available to the Task Force suggest a steady increase in demand for HCFC-22 as a feedstock in the main producing country, from around 90,000 metric tonnes per year in 2007 to around 174,000 metric tonnes per year in 2009. These figures include both feedstock for domestic use and for export. Continued growth, even at a lower rate, is likely to outstrip the reductions in consumption for dispersive uses to meet the Protocol freeze in 2013 and 10 percent reduction in 2015, and possibly the 35 percent reduction in 2020. In this event, HCFC-22 from plants that are currently producing for dispersive, controlled uses and that can meet feedstock product quality requirements might be absorbed by the feedstock market without the need for plant closure.

To the extent that any early production closure were to happen, it is likely to commence with decommissioning of older plants that are relatively small in capacity, have a lower potential for utilisation and typically produce a lower quality product. However not all older plants will be candidates for early closure. Under the Clean Developent Mechanism some older plants are eligible to receive CERs for the destruction of HFC-23, co-produced with HCFC-22. These plants will generate income from trading the CERs and for this reason are less likely to be offered for closure, at least until eligibility for destruction CERs ceases.

The issues mentioned above (feedstock production, generation of CERs and former closure funds) may have a significant impact on the funds for HCFC-22 production reduction and potential plant closure under the Montreal Protocol.

### *3.6.2 HCFC-141b*

HCFC-141b production only takes place in one Article 5 country that also produces other HCFCs. Some plants produce HCFC-141b alone, while there are also plants that produce HCFC-141b simultaneously together with HCFC-142b (in proportions that are dependent upon process conditions and can be varied to a degree). The country therefore has more flexibility in terms of reducing its total HCFC production in ODP terms in the most cost-effective way. In some cases (not known from non-Article 5 experience) HCFC-141b producers are producing HCFC-141b as a feedstock for the production of HCFC-142b.

As the Parties have agreed to give priority to HCFCs with higher ODP, HCFC-141b production will probably be impacted most by the phase-out activities required to meet the 2013 freeze target and the 10% reduction level in 2015. As was apparent from earlier information in this chapter, one Article 5 producing country accounts for over 70% of the HCFC-141b supplies to other Article 5 countries. Therefore the HCFC-141b production in this country may be impacted by the HCFC consumption phase-out activities in other Article 5 countries.

### *3.6.3 HCFC-142b*

Similar to HCFC-141b production, HCFC-142b is only produced by one Article 5 country. HCFC-142b is used for the production of XPS foam and in various refrigerant blends. Based on information from the country and from other projects approved so far by the Multilateral Fund, it is estimated that 90% of the HCFC-142b produced is used for XPS foam and 10% for refrigerant blends. As the phase-out of HCFC-142b in XPS foam is apparently addressed as a priority in many HCFC-142b consuming countries, it will probably result in a significantly reduced demand for HCFC-142b up to 2015. The Article 5 Party that produces HCFC-142b for consumption also produces it for feedstock; however, precise information on plants, capacity and co-production of HCFC-141b is so far lacking.

# 4 HCFC Phase-out Management Plans (HPMPs) and Multilateral Fund Business Planning

## 4.1 HPMPs

The modality adopted by the Executive Committee to give effect to decision XIX/6 of the Parties is the HCFC phase-out management plan (HPMP). Under an HPMP, an Article 5 country is provided with resources to undertake a coordinated national approach to HCFC phase-out including national policy and regulatory measures, technical assistance and assistance for phase-out in industrial processes in all sectors in which consumption of HCFCs occurs.

The first stage of a country's HPMP is intended to address achievement of the baseline freeze for HCFCs in 2013 and the 10 per cent reduction in 2015. Guidelines for the preparation of HCFC phase-out management plans were adopted by the Executive Committee at its 54th Meeting together with a funding advance to bilateral and implementing agencies to begin preparation of Stage 1. Decision 54/39 contains the guidelines and is one of the most important decisions here.

Under the guidelines, countries and implementing agencies are required to take account not only of the ozone-depleting potential of HCFCs, but also of the global-warming implications of alternative substances and technologies, and to consider any potential financial incentives and opportunities for additional resources, in accordance with decision XIX/6 of the Parties.

Countries are also required to nominate a starting point for achievement of sustained aggregate reductions in consumption. Thus the minimum level of phase-out required to achieve the 2015 control measure for HCFCs is 10 percent of the baseline consumption. HPMPs and stand alone projects so far approved have included a funding package based on levels of phase-out varying from 10 to more than 30 percent of their estimated baseline consumption.

### *4.1.1 Phase-out levels in approved HPMPs*

To date some 10 HPMPs for larger-consuming Article 5 countries have been approved. Consistent with the requirements for Stage 1 HPMPs, all the projects include undertakings that the country will meet the 2013 freeze at the baseline consumption level and the 2015, 10 percent reduction step. However most projects approved to date are funded for levels of HCFC phase-out greater than 10 percent of the baseline for consumption (in most cases, the predicted baseline consumption). Variations in funded phase-out range from the 10 percent minimum to (in one case only) about 60 percent of the baseline consumption.

Accordingly, in determining the lower bound for calculation of replenishment levels for the first triennium (2012-2014) the RTF has used as a minimum phase-out requirement HCFC consumption equivalent to a 10 percent reduction from the baseline for each non-LVC country. In determining the upper bound, the RTF has used as a maximum phase-out requirement HCFC consumption equivalent to a 20 percent reduction from the baseline for each non-LVC country (with the exception of China in Group 1, which is considered separately).

The RTF notes that despite phase-out greater than the 10 percent minimum reduction in consumption being included in approved stage I HPMPs for non-LVC countries, the Executive Committee has not at this stage adopted any policies that would prevent an Article 5 country submitting a follow-on proposal for a stage II HPMP upon completion of the stage I project in 2014. In considering phase-out requirements for subsequent triennia 2015-2017 and 2018-2020, the RTF has therefore taken as an upper bound the combined phase-out needed to achieve an additional 25 percent reduction in the baseline for each non-LVC country. On this basis, the total maximum phase-out funded by the Multilateral Fund by the year 2020 could amount to 45 percent of the starting point (i.e. the additional 25 percent reduction between 2015 and 2020 plus the average maximum of 20 percent of the starting point funded in stage I HPMPs).

### *4.1.2 HPMP Preparation*

The cost structure and funding levels for preparation of the first stage of an HPMP were established in Executive Committee decisions 55/13 and 56/16.

Funding levels for all non-investment activities supporting HCFC phase-out (including the servicing sector) are based on a country's HCFC consumption levels for 2007, as reported under Article 7, as follows:

| **Groups according to 2007 consumption** | **Funding for non – investment activities** |
|---|---|
| Countries with zero consumption of HCFCs | US$ 30,000 |
| Countries with consumption only of HCFC-22, or consumption below 6 ODP tonnes/year | US$ 85,000 |
| Countries with medium consumption, between 6 ODP tonnes/year and 100 ODP tonnes/year | US$ 150,000 |
| Countries with high consumption, between 100 ODP tonnes/year and 1,200 ODP tonnes/year | US$ 195,000 |
| *Countries with a consumption above 1,200 ODP tonnes/year (China only)* | Individual consideration |

Those LVC countries with HCFC-based manufacturing capacity may receive additional funding for the first stage of an HPMP to develop investment activities for the relevant manufacturing sectors. Funding is based on the total number of enterprises in each sector or sub-sector to be converted under stage I of the HPMP (excluding those enterprises with already approve demonstration projects, see below). Funding provisions are as given below.

| **Number of enterprises in the sector/subsector (excluding approved demonstration projects)** | **Funding for components 55/13(d)** |
|---|---|
| One enterprise to be converted in a manufacturing sector | US$ 30,000 |
| Two enterprises to be converted in a manufacturing sector: | US$ 60,000 |
| Three to 14 enterprises to be converted in a manufacturing sector | US$ 80,000 |
| Fifteen or more enterprises to be converted in a manufacturing sector | USD 150,000 |

The total funding available for all sub-sector plans in each sector should not exceed US$ 150,000. Similar to components (a) to (c) above, these provisions do not apply to China, which will be considered individually.

### *4.1.3 HPMP funding policies*

The major variables relating to funding of HCFC investment projects were quantified by the Executive Committee in landmark decision 60/44. The full text of decision 60/44 can be found in Annex 2.

In particular, in regard to the eligibility for funding of recently installed equipment, the Executive Committee agreed not to consider any projects to convert HCFC-based manufacturing capacity installed after 21 September 2007 (decision 60/44(a)).

In regard to the conversion of HCFC-based equipment that had previously received funding for conversion from CFC use to HCFC use (second stage conversions), the Committee agreed that:

**(i)** full funding of eligible incremental costs of second-stage conversion projects will be considered in those cases where an Article 5 Party clearly demonstrates in its HPMP that such projects are necessary to comply with the Montreal Protocol HCFC targets up to and including the 35 per cent reduction step by 1 January 2020 and/or are the most cost-effective projects measured in ODP tonnes that the Party concerned can undertake in the manufacturing sector in order to comply with these targets;

**(ii)** funding for all other second-stage conversion projects not covered under paragraph (b)(i) above will be limited to funding for installation, trials, and training associated with those projects.

The Committee further agreed that the current cost-effectiveness threshold values used for CFC phase-out projects in (referred to in paragraph 32 of the final report of the 16th Meeting of the Executive Committee (document UNEP/OzL.Pro/ExCom/16/20)), to be measured in metric kilograms, will be used as guidelines during the development and implementation of the first stage of HPMPs.

Additionally, funding of up to a maximum of 25 per cent above the cost effectiveness threshold is provided for projects when needed for the introduction of low global warming potential (low-GWP) alternatives.

In regard to the priority to be given to investment/phase-out projects of various types, the Executive Committee advised Article 5 countries and implementing agencies as follows (decision 59/11):

- to submit, as a priority, HCFC-141b phase-out projects to enable compliance with the reductions in consumption for the years 2013 and 2015, in accordance with decision XIX/6 of the Parties

- to consider HCFC consumption phase-out projects for HCFCs with ODP lower than HCFC-141b, where national circumstances and priorities required their submission, in order to comply with the 2013 and 2015 control measures.

### *4.1.4 Low Volume Consuming Countries*

For HCFCs the Executive Committee decided that LVC countries would be defined as Article 5 countries that have total HCFC consumption of up to 360 metric tonnes. A majority of Article 5 countries meet this criterion and find in addition that their entire HCFC consumption is used in the refrigeration servicing sector.

| Consumption (metric tonnes)* | Funding up to 2015 (US$) | Funding up to 2020 (US$) |
|---|---|---|
| 0 – 15 | 51,700 | 164,500 |
| 15 - 40 | 66,000 | 210,000 |
| 40 - 80 | 88,000 | 280,000 |
| 80 – 120 | 99,000 | 315,000 |
| 120 - 160 | 104,500 | 332,500 |
| 160 - 200 | 110,000 | 350,000 |
| 200 - 320 | 176,000 | 560,000 |
| 320 - 360 | 198,000 | 630,000 |

(*) Level of baseline HCFC consumption in the refrigeration servicing sector

The funding to be provided for LVC countries for phase-out in this sector was established in decision 60/44 and is indicated in the table above. HPMPs for LVC countries must contain a commitment to meeting, without further requests for funding, at least the freeze in 2013 and the 10 per cent reduction step in 2015, and if the country so decides, the 35 per cent reduction step in 2020 as well as a commitment to restrict imports of HCFC-based equipment if necessary to achieve compliance with the reduction steps and to support relevant phase-out activities. The small number of LVC countries that have some level of HCFC consumption in the foam or refrigeration manufacturing sectors may submit investment projects, in addition to receiving funding for the servicing sector.

## 4.2 Multilateral Fund Business Planning

To manage the business of the Multilateral Fund the Executive Committee has developed two planning tools: a "Model Rolling Three Year Phase-out Plan" (MRPP) and an annual Consolidated Business Plan (CBP).

### *4.2.1 Model Rolling Phase-out Plan*

The MRPP is based on an analysis of the phase-out needs of each Article 5 country to meet Protocol phase-out schedules. The analysis takes into consideration the latest Article 7 data for each ODS consumed or produced used in the country and, for ODS not yet subject to a Protocol freeze, projections of future levels of consumption until the freeze takes effect. From these are deducted the quantities of ODS that are planned to be phased out upon completion of projects and activities for which funding has been approved. The balance of 'unaddressed' consumption provides an indication of the phase-out needs of each Article 5 country in the next three years. The summation of these requirements gives a perspective of the potential overall phase-out task facing the Multilateral Fund.

In regard to HCFCs, the 2011-2013 MRPP was based on consumption data reported under Article 7 of the Montreal Protocol for the period 2000 to 2009. Estimates of HCFC consumption in 2010 were based on a growth rate of 8 per cent, used also by the Secretariat in the revised consolidated 2010-2014 business plan noted by the Executive Committee at its 61st Meeting. For consumption in 2011 and 2012 an annual rate of 6 per cent was used, consistent with the growth rate used in the 2010-2013 MRPP updated model rolling three-year phase-adopted by the Committee one year earlier at its 59th Meeting. In view of the need at a national level to comply with Protocol consumption limits from the end of 2012, the Secretariat noted that net annual growth might be curtailed to a figure lower than 6 percent. It also decided not to include growth in 2012 in the analysis on the basis that countries would need to be decreasing consumption during 2012 in order to meet the 1 January 2013 freeze.

On this basis, the total HCFC consumption to be phased out with the assistance of Multilateral Fund resources was assessed in the MRPP to be in the order 34,000 ODP tonnes. A maximum of 3,922 ODP tonnes would need to be phased out to meet the 2013 freeze. An additional phase-out of 3,378 ODP tonnes would need to be phased out over the two year period 2013-2014 to meet the 2015, 10 percent reduction target. The 2011-2013 MRPP was noted by the Executive Committee but was not, on this occasion, endorsed as a flexible guide for business planning, as had been the case in all previous years.

The MRPP analysis does not extend to inclusion of full details concerning the eligibility for funding of the unaddressed consumption or production according to the Executive Committee's rules and policies. For instance, consumption in equipment and production capacity installed only recently may not be eligible for funding. Thus the Task Force has viewed estimates in the MRPP as an upper bound indicator of the resource requirements facing the Multilateral Fund.

### *4.2.2 Consolidated Business Plan*

The CBP is constructed through amalgamation of project proposals from Article 5 countries submitted in the business plans of individual bilateral and implementing agencies. The 2010 CBP encompassing, for the first time, the five-year period prior to entry into force of the 10 percent HCFC reduction target in 2015, was initially submitted to the Executive Committee at its 60th meeting. It contained projects and activities with a total value of US$ 1,948 million, 120 percent above the funding estimated to be available for the remainder of the current triennium and for assumed continuation of funding at the same level.

The Committee requested that the CBP be resubmitted to the next meeting and issued additional guidance for its preparation, inter alia, concerning the need to ensure the consumption included for phase-out to meet Protocol limits was consistent with one of the two agreed options for determination of the starting point for aggregate sustained reductions in consumption. The total value of proposed 2010-2014 funding in the revised CBP submitted to the 61$^{st}$ meeting of the Executive Committee was US$ 1,205.5 million, which remained 35 percent above the financial guidance level. Proposed funding for 2010 was US$ 204.6 million compared to resource availability of US$ 193.9 million. Following further consultations, in decision 61/5 the Executive Committee took a number of additional measures to align agencies' project proposals with existing Committee decisions and endorsed the 2010 CBP.

For the 2011 CBP, the value of all the activities submitted by the bilateral and implementing agencies exceeded the total budget for the period 2011-2014 by approximately US$ 231 million, although the level for 2011 was US$ 4.6

million below the available funding in 2011. Adjustments recommended by the Secretariat reduced the total budget deficit to US$ 147.7 million. Noting that there had been considerable improvement in reducing over-programming compared to the previous year's business plans, the Committee endorsed the adjusted 2011 CBP.

### *4.2.3 Consumption growth 2009-2010*

Noting that 2010 HCFC consumption in Article 5 countries will not be known until late in 2011, and that consumption projections for 2010 materially affect the determination of the HCFC consumption baseline and thus replenishment funding obligations, the RTF sought to corroborate the 8 percent growth between 2009 and 2010 used in the 2011 MRPP analysis. Extrapolation of total Article 5 HCFC consumption between 2005 and 2009 using both logarithmic and linear algorithms indicated 2009-2010 growth to be of the order of 8.3 to 8.4 percent with a confidence level of 85 percent as indicated in the table below. The RTF has therefore adopted the 8 percent level as used in the MRPP.

| Type of growth | Confidence | **2005** | **2006** | **2007** | **2008** | **2009** | **[2010]** |
|---|---|---|---|---|---|---|---|
| Actual | | 2146 | 2728 | 3165 | 3017 | 3442 | |
| Linear | R2=0.851 | 2333 | 2621 | 2909 | 3197 | 3485 | 3774 |
| | | | **124%** | **110%** | **99%** | **90%** | **83%** |
| Logarithmic | R2=0.851 | 2278 | 2565 | 2855 | 3143 | 3431 | 3719 |
| | | | **127%** | **112%** | **101%** | **92%** | **84%** |

# 5 Cost effectiveness considerations for HPMPs

## 5.1 Foam

The status of the HCFC options for the different foam applications was reviewed in detail in the 2006 UNEP Foams TOC Report and the subsequent annual progress reports. The TEAP Report responding to Decision XXI/9 provides a review of options that might minimise the climate impact of transitions to non-ODP substances.

Today two types of polymeric foams use HCFCs as blowing agents: Polyurethane (PU) Foams (mainly HCFC-141b and some HCFC-22) and Extruded Polystyrene (XPS) Board Foams (HCFC-142b and HCFC-22). They compete with other materials, like mineral fibres, EPS in thermal insulation and other applications. The PU foam sectors using HCFCs are insulating foams, integral skin foams and microcellular foams (shoe soles). In the last two sectors the usage is much less than in the insulating market because of the smaller overall market and the higher foam density. XPS board foams are mainly used for insulation purposes.

The proven HCFC alternative options for foams include hydrocarbons, high GWP HFCs and carbon dioxide (water). Key points to highlight these options are:

- The main route for PU foams is to use hydrocarbons (HC), principally pentanes (n-pentane, cyclopentane, iso-pentane and their blends). Technologies have been well established to allow their safe use, with the only exception of spray applications.
- Formulations for PU foams based on hydrocarbons have been refined and their insulation performance, as expressed by foam thermal conductivity, is similar to those for HCFC-based foams. Additional to the low GWP of HCs, the improved insulating value would eventually provide indirect climate benefits.
- Capital costs for conversions to hydrocarbons are significant -a critical issue for small size enterprises- but the use of such technologies provides lower operating costs than in the case of other alternatives such as HFCs. It is estimated that the minimal Incremental Capital Costs (ICC) for the conversion to HC are in the range of 300,000 to 500,000 dollars.
- In addition to their high GWP, the use of saturated HFC-based technologies (HFC 245fa, HFC-365mfc/HFC-277ea) may result in significant increases in operating costs due to their higher unit prices and molecular weights. Generally, incremental capital costs are not required in the case of conversions to HFCs.
- Reduced HFC formulations -using $CO_2$ from water as co-blowing- have been developed to minimise the climate impact derived from the high GWP of the substance and to decrease foam cost.

- The technology based on $CO_2$, derived from the isocyanate-water reaction, has been used with limited success for commercial refrigeration (bottle displays, exhibitors) where insulation performance is not critical. Its major drawbacks are the relative poor insulating performance resulting from the relatively high lambda value of $CO_2$; the required increase in foam moulded density caused by the high permeability values of $CO_2$ through the polyurethane matrix; and the reduced "adhesion" to the substrates where it is applied (metal, thermoplastics), a consequence of the high amount of polyurea present in the polymer.
- Nevertheless, various PU chemicals suppliers are recently promoting new water blown technology. It is claimed that these improved water blown systems allow easy filling of the cavities and can be processed with a mould temperature of 40°C. As a result of improved flow and optimised density distribution the applied densities would be in the same range of HFC/HCFC low-level technology with minimum impact on foam dimensional stability and mechanical properties. This is expected to bring the foam cost down to the level of HCFC based foams
- In the Japanese spray market, the use of water blown foam along with patented super-critical $CO_2$ technology has been introduced and reached significant levels of market penetration; there may be limitations in some applications. Nonetheless, this technology is now become the focus of a MLF supported pilot-project which might shed more light on the potential.

An analysis of the above proven options indicates that a primary challenge for the foam sector is the phase-out of HCFCs in the large number of small and medium size enterprises currently existing in the Article 5 countries. New technology alternatives for this particular interest have recently emerged or are emerging:

***Pre-blended hydrocarbons (HC):*** Efforts have been made to reduce costs at the foam manufacturers by pre-blending the hydrocarbons into polyols at systems houses.

A very good example is BaySystems Northern Europe in Denmark, a system house that for a long time has been delivering formulated polyols containing cyclopentane in one-tonne containers and 200 l drums to different industries in Eastern and North-Eastern Europe. This approach allows reduced investments on the user's side without compromising the insulating efficiency and the long-term dimensional stability performance. BaySystems' experience shows that investment in one blending facility may make it possible to reduce investments in manufacturing plants.

While the cost of HC storage tanks, pumps and premixing stations can be avoided, the safety modification and partial replacement of the foaming line and installation of safety monitoring and ventilation systems will still be required. It is estimated that savings in ICC for the end user are in the order of

25 to 35 %. The Multilateral Fund together with the Implementing Agencies have taken up the matter and two pilot projects have been sponsored (China and Egypt).

***Methyl Formate (MF):*** This substance is being promoted as a blowing agent under the trade name of Ecomate by Foam Supplies, which has patented the application in several countries. 365 tonnes were consumed world-wide in 2009 and close to 1,000 in 2010 (the FTOC estimated the total 2005 foam market at 360,000 tonnes of blowing agent). It is used in the flexible moulded and integral skin foam applications. It is also applied in limited quantities for some rigid foam applications, particularly in the less insulating demanding, commercial refrigeration and discontinuous panels. The application of this technology requires establishment of a licensed network of system houses in each country concerned.

Further discussion on MF technology can be found in the FTOC 2010 assessment report.

***Methylal:*** Lambiotte, a Belgian chemical company, and others are promoting this blowing agent for PU applications. There is no industrial experience of its use as sole auxiliary blowing agent. The safety implications of its flammability characteristics plus the foam properties resulting from its use need to be clarified and verified.

This blowing agent is also being further evaluated in one MLF supported pilot project (Brazil).

***Unsaturated HFCs (HFOs):*** These compounds represent an emerging group of potential blowing agents that exhibit a number of the characteristics also displayed by saturated HFCs, but have considerably lower GWPs (< 15). The prime reason for these lower values relates to the shorter lifetime of the molecules in the atmosphere caused by the presence of a double bond between adjacent carbon atoms.

Intensive research on their performance characteristics is being done by the fluorochemical companies (Arkema, DuPont and Honeywell) but it is clear that, despite some very promising results, these compounds are unlikely to be available in time to meet the early stages (pre-2015) of the HCFC phase-out as required under Decision XIX/6. Cost prediction is similar to saturated HFCs.

Summarizing, several new blowing agents are emerging and their evaluation is in progress. The data that should be obtained using standard test methods include toxicology and ecotoxicology testing, processing characteristics (stability in polyol blends, miscibility with polyols, foam ability to flow, moulding times, atmospheric concentrations during processing, effects on equipment) and physical properties (closed cell content, density/strength

relationship, dimensional stability versus temperature and ageing using accelerated methods, thermal conductivity versus temperature and ageing using accelerated methods, foam friability, adhesion to different substrates, fire code testing for construction industry foam-based components, water vapour transmission, cell gas composition with time) and trials under commercial production conditions and long term testing of articles.

In PU foam, hydrocarbons have been the preferred selected technology to replace HCFCs in large consuming companies, while saturated HFCs, $CO_2$ (water and supercritical) and methyl formate have been chosen for companies with lower consumption.

The average Cost Effectivenesses (CE) for the HCFC conversion projects approved by the ExCom, based on the total project costs, are calculated as US$ 7.21/kg for PU foam and US$ 2.56/kg for XPS.

***Table 5-1 Cost effectivenesses calculated from project approvals***

| Foam Sub-Sector | HCFC-141b tonnes | Technology | Total cost, US$ | CE, US$/kg |
|---|---|---|---|---|
| Domestic Refrigeration | 2,457.1 | Cyclopentane | 21,096 | 8.59 |
| Spray | 15.2 | HFC-245fa | 194 | 12.75 |
| Spray | 102.0 | Methyl Formate | 178 | 1.75 |
| Water heaters | 22.0 | Methyl Formate | 125 | 5.66 |
| Discontinuous Panels | 1,134.0 | N-pentane | 3,896 | 3.44 |
| Multi sectors | 522.2 | Various | 5,178 | 9.92 |
| TOTAL | 4,252.5 | | 30,665.20 | 7.21 |

The ExCom decision 60/44 defined as guidelines for the cost effectiveness threshold values the same that were using in the CFC phase-out projects to be measured in metric kilograms: US$ 7.83/kg for rigid polyurethane foam, 16.86 for Integral Skin and 8.22 for polystyrene. Funding of up to a maximum of 25 % above the cost effectiveness threshold value will be provided when required for the introduction of low GWP alternatives. Incremental Operating Costs (IOC) for the foam sector will be considered at US$ 1.60/kg for HCFC-141b and at US$ 1.40/kg for HCFC-142b.

### *5.1.1 Cost Effectiveness for PU foam*

The Cost Effectiveness (CE) for polyurethane (PU) foams depends on the chosen HCFC phase-out technology and the size of the enterprise. The selection of the technology is greatly influenced by the specific market subsector (integral skin, domestic refrigeration, commercial refrigeration, discontinuous and continuous panels, spray, etc.) and the size of the company to be converted.
Table 5-2 presents the preferred conversion technologies by PU foam subsector and company size. Based on this information and the data of

approved and submitted projects the CE values -by subsector and company size- were estimated in Table 5-2.

To calculate a weighted average, Table 5-3 --describing the estimated market distribution, in percentage, by subsector and company size-- was prepared. Combining the tables 5-2 and 5-3, the weighted CE averages can be calculated for the sub-sectors: US$ 7.07 for rigid foam and US$ 11.0 for integral skin. The global weighted average for PU foam resulted in US$ 7.27/kg, which is very similar to the average of the approved projects (US$ 7.21/kg).

***Table 5-2 Preferred Technologies by subsector and company size***

| | **Size of the production lines** | | |
|---|---|---|---|
| **Foam sub-sectors** | **ODS>40 MT** | **10 MT<ODS<50 MT** | **ODS<10 MT** |
| Integral Skin | | Water & Methyl Formate & Pre-blended HC | Water & Methyl Formate |
| Rigid Foam | | | |
| Domestic Refrigeration | HC | HC | |
| Commercial refrigeration | HC | Pre-blended HC | Water (alone or modified with formic acid, methyl formate, etc.) |
| Continuous Panels | HC | Pre-blended HC | |
| Discontinuous Panels | HC | Pre-blended HC | Water (alone or modified) |
| Spray | | | Water & HFC-245fa & Supercritical CO2 |

***Table 5-3 Estimated Cost Effectiveness by subsector and company size***

| | **Size of the production lines** | | |
|---|---|---|---|
| **Foam sub-sectors** | **ODS>40 MT** | **10 MT<ODS<50 MT** | **ODS<10 MT** |
| Integral Skin | | 6.00 | 16.00 |
| Rigid Foam | | | |
| Domestic Refrigeration | 8.60 | 9.50 | |
| Commercial refrigeration | 8.60 | 9.79 | 3.00 |
| Continuous Panels | 6.00 | 6.50 | |
| Discontinuous Panels | 7.00 | 7.50 | 3.00 |
| Spray | | | 4.00 |

*Table 5-4 Market Distribution by Foam Subsector and Companies Size (%)*

| | Size of the production lines | | | |
|---|---|---|---|---|
| **Foam sub-sectors** | **ODS>40 MT** | **10 MT<ODS<50 MT** | **ODS<10 MT** | **Percent of Total Market** |
| **Integral Skin** | | 50 | 50 | 5 |
| **Rigid Foam** | | | | 95 |
| | | | | Percent of Rigid Foam |
| Domestic Refrigeration | 80 | 20 | | 30 |
| Commercial refrigeration | 5 | 75 | 20 | 20 |
| Continuous Panels | 90 | 10 | | 10 |
| Discontinuous Panels | 5 | 80 | 15 | 20 |
| Spray | | | 100 | 20 |

*Table 5-5 Average Cost Effectiveness by Sub-sectors*

| **Foam sub-sectors** | **By Sub-sector** | **By Sector** | **TOTAL** |
|---|---|---|---|
| Integral Skin | 11.00 | 11.00 | 7.27 |
| Rigid Foam | | 7.07 | |
| Domestic Refrigeration | 8.78 | | |
| Commercial refrigeration | 8.37 | | |
| Continuous Panels | 6.05 | | |
| Discontinuous Panels | 6.80 | | |
| Spray | 4.00 | | |

### *5.1.2 Cost effectiveness for XPS foam*

In North America the extruded polystyrene sector has successfully made its transition out of HCFCs, although, for the most part, this has been to solutions involving various combinations of saturated HFCs. There is interest in Europe, primarily driven by market pressure to move to low GWP alternatives. Those solutions evaluated include dimethylether and unsaturated HFCs. Isobutane is also a strong candidate considered by Japan and other countries.

As stated in the 2010 FTOC assessment report the extruded polystyrene sector is continuing to grow rapidly in China and elsewhere in Asia. It seems unlikely that HFCs will make major in-roads in the markets for reasons of cost and availability. Therefore, the most likely solution will be based on hydrocarbons, on their own or in blends. The level of investment needed to support this is unclear, but, since the plants are relatively small, and there is

parallel experience with extruded polystyrene sheet, it may be that the transition will be less challenging than currently envisaged. CO2 seems unlikely as a solution in isolation.

The cost effectiveness for XPS foam depends on the chosen technology - strongly associated to the foam thermal performance requirements- and the size of the enterprise. The Executive Committee has so far approved conversion projects in two countries. Although, when original submitted the cost effectivenesses (in US$/kg) were 3.11 (isobutane), 5.21 (HFC-152a/dimethylether), and 7.66 (isobutane), the final approved values were 1.21, 2.81 and 3.55 respectively. Because of the lack of a comprehensive set of data it was decided to take the weighted average value of the approved projects, US$ 2.56/kg, as the cost effectiveness for the conversion cost calculations. This figure can be modified accordingly, when information on more projects will become available.

## 5.2 Refrigeration and air conditioning

HCFC-22, HCFC-123, HCFC-142b and HCFC-124 are HCFC refrigerants used in refrigeration and air conditioning applications, with HCFC-22 being by far the most important in Article 5 countries. Commercial refrigeration is composed of three main categories of equipment: stand-alone equipment, condensing units, and centralised systems. The quantity of HCFC used within stand-alone equipment is negligible, so only condensing units and centralised systems are considered. Air conditioning includes a broad range of products each having their own specific technical requirements. Air conditioning can be broken into four main categories: air-to-air (unitary), multi-split/variable refrigerant flow (VRF), chillers and heating only heat pumps. Throughout, consideration is only given to new systems and not conversion or retrofit of existing systems.

A comprehensive description of the refrigerant technology options can be found in the 2010 UNEP RTOC Assessment Report published February 2010 (http://ozone.unep.org/teap/Reports/RTOC/index.shtml). The technology options were identified as “current”, meaning that they are applied at the present time or in some cases their introduction is imminent, whereas “longer term” implies that the technology is anticipated to be available within the next 3-5 years. Nearly all of the options have special considerations associated with them. Due to these considerations, both have incremental capital cost (ICC) and incremental operating cost (IOC) implications, but they also impact upon the feasibility of the application of the technology. In order to estimate the potential uptake (on a solely technical and cost basis) of a particular option, penetration values were estimated for each. These potential penetration values were then combined with the estimated costs employed to estimate the ICC and IOC for an entire sub-sector under different scenarios.

Table 5-6 presents these penetration values; this table also clearly shows the sub-sectors and the different technologies within those sub-sectors.

However, it must be recognised that there are considerable uncertainties associated with the estimation of ICC and IOC for a given refrigerant option. These include:

- Size of the enterprise
- Extent of product development within an enterprise
- Maturity of the product and option
- Extent of spread and maturity of the technology throughout an industry
- Status of patents and technology licences
- Range of models and system capacities
- Refrigerant charge quantity of existing models
- Whether the enterprise produces heat exchangers internally or sources externally
- Country/geographical location

Therefore the estimation of the cost-effectiveness values – which broadly represent the best judgement of experts – is provided below. However, since the IOC of the sub-sectors are essentially capped (according to decision 60/44) a greater emphasis was given to the accuracy of the ICCs.

Based on the individual sub-sector cost-effectiveness values and the minimum and maximum penetration rates for the low-GWP options, the cost-effectiveness values have been determined. The ExCom decision 60/44 (see Annex 2) defined as guidelines for the cost effectiveness threshold values the same that were using in the CFC phase-out projects to be measured in metric kilograms.

***Table 5-6 Estimated maximum penetration values for various refrigerant options***

| Sub-sector | Option | Current | Longer term | Key constraints |
|---|---|---|---|---|
| Condensing units | R404A, R410A, HFC-134a | 100% | 100% | |
| | HFC-32 | 10% | 70% | Flam |
| | Unsat. HFC/HFC blends | 0% | 70% | Cost |
| | HC-290, HC-1270, etc | 5% | 30% | Flam |
| | R-744 | 0% | 10% | Effy |
| | HC-290, HC-1270, etc + indirect | 0% | 20% | Cost |
| | Unsat HFC (HFC-1234yf, etc) | 0% | 50% | Cost, Flam |
| | Total low-GWP | 5% | 100% | |
| Centralised systems | R-404A, R-410A, R-407A, R-407C, HFC-134a | 100% | 100% | |
| | Unsat. HFC/HFC blends | 0% | 40% | Cost |
| | R744 (sub/transcritical) | 5% | 5% | Effy, cost |
| | HFC-134a, etc + R-744 (cascade) | 20% | 40% | Cost |
| | HFC-32 + R-744 (cascade) | 20% | 40% | Cost |
| | HC + R-744 (cascade) | 20% | 40% | Cost |
| | Unsat HFC + R-744 (cascade) | 20% | 40% | Cost |
| | HFC-134a, etc + indirect liquid/CO2/distrib indirect | 20% | 40% | Cost |
| | HFC-32 + indirect liquid/CO2/distrib. indirect | 20% | 40% | Cost |
| | HC + indirect liquid/CO2/distributed indirect | 20% | 40% | Cost |
| | Unsat HFC + indirect liquid/CO2/distrib indirect | 20% | 40% | Cost |
| | Total low-GWP | 25% | 50% | |
| Chillers | R410A, R407C, HFC-134a | 100% | 100% | |
| | Unsat. HFC/HFC blends | 0% | 60% | Cost |
| | HFC-32 | 20% | 70% | Flam |
| | HC-290, HC-1270, etc | 20% | 30% | Flam |
| | R717 | 20% | 20% | Tox, cost |
| | R744 | 5% | 10% | Effy, cost |
| | Unsat HFC (HFC-1234yf, etc) | 0% | 50% | Cost, flam |
| | Total low-GWP | 45% | 100% | |
| Unitary air conditioning | R-410A, R-407C | 100% | 100% | |
| | Unsat. HFC/HFC blends | 0% | 60% | Cost |
| | HC (R290, R1270, etc) | 30% | 40% | Flam |
| | R744 | 5% | 10% | Effy, cost |
| | Unsat HFC (HFC-1234yf, etc) | 0% | 40% | Cost, flam |
| | HFC-32 | 30% | 60% | Flam |
| | Total low-GWP | 35% | 100% | |
| Multi-split | R410A | 100% | 100% | |
| | Unsat. HFC/HFC blends | 0% | 60% | Cost |
| | R744 | 5% | 10% | Effy, cost |
| | Unsat HFC (HFC-1234yf, etc) | 0% | 30% | Cost, flam |
| | HFC-32 | 20% | 50% | Flam |
| | Total low-GWP | 5% | 70% | |
| Heating only heat pumps | R-410A, R-407C, HFC-134a | 100% | 100% | |
| | Unsat. HFC/HFC blends | 0% | 60% | Cost |
| | HC (R290, R1270, etc) | 30% | 50% | Flam |
| | R744 | 50% | 70% | Cost |
| | Unsat HFC (HFC-1234yf, etc) | 0% | 70% | Flam |
| | HFC-32 | 30% | 70% | Flam |
| | Total low-GWP | 80% | 100% | |

NB: “flam” = flammability; “tox” = higher toxicity; “effy” = efficiency

*Table 5-7 Estimated cost-effectiveness values for a combination of various refrigerant options; scenario 2 considers a share of about 25% low-GWP options for the current situation and a share of about 90% for the long term*

| Scenario | Time scale | Average incremental costs | | | |
|---|---|---|---|---|---|
| | | Comm. refrigeration | | Air conditioning | |
| | | ICC | IOC | ICC | IOC |
| Scenario 1 High GWP only | Current | 7 | 10 | 4 | 8 |
| | Longer term | 5 | 9 | 3 | 6 |
| Scenario 2A- Low-GWP split | Current (~25%) | 7 | 26 | 4 | 8 |
| | Longer term (~90%) | 3 | 36 | 2 | 23 |
| Scenario 2B- Only low-GWP | Current | 7 | 72 | 4 | 11 |
| | Longer term | 3 | 54 | 2 | 25 |

For this report, the scenario 2A as presented in Table 5-7 was chosen (25% low-GWP share for current replacements) was chosen due to the fact that it can be assumed that low-GWP options only (scenario 2B) cannot be realised at this moment (by the way, the limitation of IOCs in Decision 60/44 would not cause any differences in the cost effectiveness value, whatever kind of scenario 2).

This implies a cost effectiveness of US$ 10.8 /kg for (current) commercial refrigeration (IOC capped at US$ 3.8/kg) and a cost effectiveness of 10.3 US$/kg for (current) air conditioning (IOC capped at US$ 6.3/kg), excluding the increase of up to 25%, where needed, for the application of climate friendly low-GWP options. The share of low-GWP options is currently assumed at 25% for both commercial refrigeration and air conditioning on a combined HCFC-22 mass basis (see Table 5-7, scenario 2A).

Assuming a share of about 70% for AC in the total HCFC-22 consumption for manufacturing (averaged per country), the cost effectiveness value can be determined. With a 30 percent share of commercial refrigeration in the total manufacturing one can derive a value of US$ 3.24/kg; a 70 percent share of air conditioning in the total yields a value of US$ 7.21/kg.

On the total cost effectiveness of US$ 10.45/kg an addition has to be applied for the introduction of low-GWP options. With the 25% share assumed for low-GWP options, it has been assumed that this number should be increased by 25%, which can be applied at maximum (needed because of the assumed higher cost effectiveness); it equals about US$ 0.65/kg. This then yields a cost effectiveness for the “averaged” HCFC-22 manufacturing sectors of US$ 11.1/kg.

# 6 Methodology for Determining Funding Requirements

The funding requirement for new HPMPs in the replenishment 2012-2014 has been calculated using a spreadsheet analysis. This chapter describes the way these calculations were done, as well as the input parameters that can be varied according to the scenarios that are selected.

## 6.1 Input parameters

The following input parameters have been chosen (these are in principle valid for all Article 5 countries studied in the spreadsheet analysis, although these can always be overruled by setting specific values for a specific country if necessary):

- The baseline. In principle the baseline consumption is the average of the 2009 and the 2010 aggregated HCFC consumption (2010 consumption is assumed to be 1.08 times the 2009 consumption, see chapter 4).

- The reduction that should apply in 2015 expressed as a percentage reduction from the baseline (or freeze) consumption (which is 10% following Decision XIX/6).

- Cost effectiveness. Relevant cost effectiveness values for PUR foam conversions, XPS foam conversions, commercial refrigeration and AC conversions, as well as for refrigeration and AC servicing consumption reductions are used as established in chapter 5. For the refrigeration and AC servicing sector the value of US$ 4.5 per kg HCFC has been established by the Executive Committee in Decision 60/44.

- The percentage of HCFC-22 consumption in a country that is used for servicing. This is normally assumed to be 70%, with 30% for commercial refrigeration and air conditioning manufacturing. In some exceptional cases the percentage is set as 60% for servicing (in case of large manufacturing capacities), in others as 80-85% servicing (in case of small refrigeration and AC HCFC consumption, and large foam manufacturing capacities).

- The sub-sectoral composition of a given level of reductions in HCFC composition (the "reduction package"). In the spreadsheet the composition of the sub-sectors in the reduction package can be chosen in percentages for the different sub-sectors (with the values in units of ODP tonnes). One can give the percentage of HCFC reductions involved in foams; the spreadsheet then calculates the amounts involved in the PUR and XPS sub-sector on the basis of the percentages of these sub-sectors in the total foam consumption of the country. One can also give the percentage reduction in refrigeration and AC manufacturing and in servicing as a

percentage of the total in ODP tonnes, or as percentages of the total HCFC-22 consumption of a country.

- In principle one can vary the percentage for commercial refrigeration and the percentage for air conditioning in reductions for the refrigeration and AC sub-sectors. A variation will then lead to a variation in the overall cost effectiveness value. One can also define how much of the conversions in each of the sub-sectors consists of a conversion to low-GWP alternatives and add 25% to the cost effectiveness value for those cases. In principle the composition as given in chapter 5 is used, but variations are possible.

- In the case of a very small consumption of HCFC-141b in a country it is assumed that this chemical is used for flushing and cleaning purposes. A phase-out of this chemical is then assumed to be part of the improvement in servicing practises achieved through activities funded under the servicing sector.

- In the case of a very small consumption of HCFC-142b in a country (and no indications of XPS manufacture) it is assumed that this chemical is used as part of a refrigerant blend (used in retrofits). This blend is assumed to be part of the refrigerant amount used for servicing and will also be addressed through servicing sector activities.

- If funding is calculated for a certain reduction by 2015, the funding is assumed to be provided in tranches, with a certain percentage per year. In this way one could e.g. assume that, for HPMP stage I projects approved in 2011, the funding would be provided via a 40%-20%-20%-20% schedule in the years 2011-2014. For projects approved in 2012 the percentages 40%-35%-25% could apply. Since the funding requirement calculation first considers the period mid-2011-2014 (and thereafter the 2012-2014 triennium) the disbursement schedule is in principle not important since they all fall within the relevant period. This would be different if certain tranches would be transferred beyond the year 2014.

- In the case of LVC countries (countries with a consumption less than 360 metric tonnes, virtually all HCFC-22) the approvals through 2010 (and also the approvals from the first ExCom meeting in 2011) are known. For LVC countries for which HPMP approvals are still outstanding, the amounts are used as given in Decision 60/44 (see also chapter 4 and Annex 1), and the disbursement is assumed to take place in four tranches, two in the period 2011-2014, one in 2016 or 2017 and one in 2020 (normally 10% of the total).

- Article 5 countries' industries are characterised by certain percentages of foreign ownership (and of exports to non-Article 5 countries) in each of

the sub-sectors. For certain countries where data were available per sub-sector (e.g., China) these percentages have been applied to the consumption in the relevant sub-sectors. Where data is not adequate, a percentage of 30% foreign ownership has been used for those Article 5 countries with significant RAC manufacturing operations.

The most important objective in this report is the calculation of the funding requirement for HCFC reductions for all Article 5 Parties in the first triennium 2012-2014 and in the two trienniums thereafter. To achieve this, the funding requirement for the period mid-2011-2014 is calculated first (the period after ExCom-63 through ExCom-74). This implies that existing commitments from approvals including ExCom-63 for mid-2011-2014 have to be taken in account.

Commitments from approvals in 2010-2011 can continue until the year 2020. This would normally apply to HPMP plans for low volume consuming countries. The commitments beyond 2014 will be taken into account in the funding calculation for the periods 2015-2017 and 2018-2020.

## 6.2 Scenarios Chosen for the Calculations

The Task Force decided to calculate a number of different funding requirements for HCFC consumption phase-down via new HPMPs (specifically for the ***mid-2011-2014*** period, from which the ***2012-2014*** funding requirement for the replenishment is being derived):

1. Funding to achieve a reduction of 10% from the estimated baseline 2009/2010 HCFC consumption by 2015; this implies somewhat higher funding than use of the 2009 consumption level, but is the starting point for reductions most likely to be adopted by the remaining Article 5 countries after ExCom-63;

2. Funding of an amount of HCFC consumption that is one and a half times the amount as considered under (1) above, equivalent to a 15 percent reduction from the baseline consumption.

3. Funding of an amount of HCFC consumption that is twice the amount as considered under (1) above, equivalent to a 20 percent reduction from the baseline consumption. This case is also considered because reductions of this order, or greater have been contained in HPMPs approved by the Executive Committee, up to and including at the 63rd Meeting. These levels of approval are assumed to not impact the calculation of the indicative amounts of funding required in the two triennia beyond 2012-2014, i.e., it is assumed that countries can request funding for further reductions after 2014 (to meet the additional 20 percent reduction required

by 2020, to be addressed in stage II of an HPMP) even if the approval for stage I has been substantially larger than 20%.

It will be shown that the choice of one of the options described above, i.e., the "10% from baseline funding", the "15% from baseline funding" or the "20% from baseline funding" is a very important parameter in the HCFC consumption funding calculations.

Since detailed consideration and approval of HPMPs takes place on a country by country basis, recent project approvals by the ExCom have shown:

1. a preference for reductions in the foam sub-sectors, plus a certain portion of reductions in the refrigeration and air conditioning manufacturing, plus servicing, or
2. reductions in the foam sub-sectors, plus reductions in the servicing sector.

The Task Force has therefore used these two preferences as the basis for a second parameter, and selected two cases for likely reduction packages, with the percentages for the relevant consumption (in ODP tonnes) in each sub-sector as follows: for the first reduction package, 90% foam, 10% servicing; for the second reduction package 75% foam, 15% R-A/C manufacturing and 10% servicing.

Together with the funding of certain reductions from the baseline, this yields in total six scenarios for HPMP funding, or in the end, six total funding requirement options for the triennium 2012-2014.

*Together with the cost-effectiveness values, the two parameters mentioned above form the main elements for the calculations of the funding requirement in the consumption sector for the triennium 2012-2014.*

## 6.3 Calculation Method

For most of the countries in the lower consumption Groups, Groups 3 and 4, phase-out plans incorporating a 35% reduction by the year 2020 are assumed, because a majority of the 46 LVC countries that have so far received funding for an HPMP have selected this option. Despite the large number of countries in Group 4 (LVCs) the funding tranches for phase-out in the servicing sector for these countries constitute only a minor contribution to the overall funding requirement.

All the larger consuming countries, to be found in Groups 1 and 2, and certain countries in Group 3 with significant non-servicing consumption, have been considered individually. The Protocol obligations of each country, and hence the total reductions in consumption required to meet the freeze and a certain percentage reduction step, are expressed in ODP tonnes. To determine the

funding it is necessary to calculate for each country the required reduction in metric tonnes for each sub-sector, in such a manner that the sum of the metric tonne reductions meets the country's total ODP tonne phase-out requirement.

Phase-out to be realised from projects and HPMPs that have already been approved by the Executive Committee is subtracted from the overall phase-out requirement used in the spreadsheet analysis since it is incorporated in the overall funding requirement under the heading of 'existing commitments' for the year 2011 or later (2012-2014).

Multiplying the tonnes (or kilograms) of reductions for each of the HCFCs consumed in a country with the relevant cost effectiveness for each sub-sector in which the HCFC is used yields the level of funding for a country (after taking into account any exports to non-Article 5 countries and the percentage of foreign ownership per sub-sector). In this way totals per country, totals per group, and the total for all Article 5 countries (under "new commitments" or new HPMPs) can be calculated.

As indicated in Section 6.1 the methodology encompasses a 4-year period, 2011-2014. By subtracting the expenditure approved at the 63rd Meeting and the balance of funding anticipated for expenditure in 2011 in the Consolidated Business Plan of the Fund, (about US$ 252.2 million), the funding requirement for the triennium 2012-2014 can be calculated. At the conclusion of the 65th Executive Committee meeting, the last for this year, the actual expenditure for 2011 could be used to further refine the triennium estimate.

Once the consumption reductions up to the year 2015 (per sub-sector and per country) have been determined, the sub-sectoral consumption distribution including refrigeration and AC has been used to calculate the funding requirement for the two subsequent triennia. Consumption reductions of an additional 31.5 percent have been assumed over this period for funding consistent with the increase in Protocol reductions from 10 percent to 35 percent of the baseline prior to 2020, plus phase-out in 2020 of 6.5 percent, being one year, pro rata, of the remaining 65 percent phase-out required by 2030.

It is assumed that 15% of this additional 31.5 percent reduction will be funded during the period 2015-2017. It is also assumed that funding tranches for this 15% further reduction (in fact, this is part of Phase II of the HPMP) will also be disbursed within the triennium.

The judgements to be made here are, firstly: what will be the composition of the reduction package (percentage foam, percentage commercial refrigeration and air conditioning manufacturing, percentage servicing), and secondly: what will be the cost effectiveness for the different sub-sectors. It is likely that with increasing market penetration and maturity of certain options, cost

effectiveness values will decrease over the period 2011-2015-2017, but at this stage it is not possible to determine the extent to which this might occur. For this reason the cost effectiveness values for the periods 2012-2014 and 2015-2017 have been kept constant.

This then yields an indicative funding amount for all HPMPs for all Article 5 countries for the triennium 2015-2017.

Once the amounts of consumption for the year 2017 (per sub-sector and per country) have been determined, it is easily possible to calculate the funding requirement for a further reduction of 16.5% during the period 2018-2019-2020, assuming that funding tranches for this 16.5% further reduction will also be disbursed within the triennium 2018-2020. It is in fact exactly the same approach as for the period 2015-2017.

## 6.4 HCFC Production Phase-out Calculations

Since Technical Audits have not yet been carried out in relevant Article 5 countries, estimates for production closure funding in this report are based on the experiences from the CFC production phase-out, estimates in the MLF Business Plans and information on present levels of production.

So far, there has not been a real audit of the different aspects of production in the various plants in different Article 5 Parties. Furthermore, the Executive Committee's Production Sector Working Group has not at this stage concluded guidelines to assist in separating HCFC-22 production for feedstock from production for dispersive use and to examine its effect on the timing of possible closure of production plants. There will also be a need for the development of policy guidance concerning the parallel production of HCFC-141b and -142b, where the HCFC-142b chemical produced is being used as a feedstock to a significant degree. For these reasons there is insufficient technical and policy information available to enable the Task Force to undertake a technical analysis of HCFC production closure and funding in any detail.

HCFC production phase-out has therefore been taken into account in the following manner:

- Production phase-out of HCFC-141b and -142b is assumed to occur in parallel with the consumption phase-out and on the basis that it will be achieved through plant closures. It is assumed to start in 2013, this being the first year with reduced production levels.
- Production phase-down of HCFC-22 is also assumed to commence in the year 2013.
- If funding is based on the experience in CFC plant closure, costs would be between US$ 2.5 and 3.5 per kg. Diversion of HCFC-22 production to

feedstock uses would result in zero cost to the MLF and reduced production for controlled uses would be ~US$ 3 per kg. At present, there is no adequate information available to estimate the HCFC-22 phase-out, which could be absorbed by increased feedstock uses. Therefore plant closures have been assumed.

- A value of US$ 3.0 per kg of HCFC-141b, HCFC-142b and HCFC-22 phased out in production has been chosen. It has been assumed that all the funding for meeting the 2015 production reduction will be approved during the triennium 2012-2014. Closure funding is assumed to continue pro-rata in the two replenishment periods thereafter.

## 6.5 HPMPs Approved Before ExCom-63 in 2011

A large number of (mostly smaller) Parties have received approval for the funding of an HPMP either to meet the 10 percent reduction step in 2015 , or, more usually to meet or exceed the 35% reduction step in 2020 (with a few exceptions where total HCFC phase-out has been planned within the funding approved for the stage I HPMP). The planned annual disbursements of the funding tranches for these projects have been established for each country and enable accurate determination of all existing commitments for the triennium 2012-2014 and where it concerns LVCs, also for the triennia 2015-2017 and 2018-2020.

Virtually all the approved plans for LVCs deal with refrigeration servicing. In addition there is often a small one-off component in foams, which is being funded in one tranche in the year of approval (i.e., the year 2010 or 2011). However, there are some exceptions, such as the HPMP for the Former Yugoslav Republic of Macedonia, approved in 2010, in which the approval of the foam component was deferred.

## 6.6 HPMP Preparation Costs

HPMPs preparation funds are not assumed to be needed in 2012 or 2013, since HPMPs are already being prepared for all countries. They will again be needed in 2013-2014 when HPMPs for the stage II projects will have to be prepared. Stage II projects will deal with additional reductions after the first (10 percent) reduction step in 2015. It will concern all those (larger HCFC consuming countries) that have received only a “stage I approval” (not the LVC countries where the plans go through to the year 2020).

It is estimated that some 60 countries will require stage II HPMPs from 2015 onwards.

## 6.7 Elements for the complete HCFC Funding Requirement

In summary, the funding requirement for HCFCs will be determined on the basis of:

(a) estimated costs for the HCFC consumption phase-down in the larger consuming Article 5 countries (Groups 1 and 2) for six funding cases (10%, 15% and 20% reduction from baseline, as well as for reductions in HCFC consumption for foam and servicing and for foam, RAC manufacturing and servicing);

(b) estimated costs for the HCFC phase-down in the servicing sector, in fact, (new) HPMPs for countries with a consumption generally smaller than 360 tonnes of HCFC-22 (but including few exceptions where consumption is greater than 360 tonnes and use is still confined to the servicing sector only); and

(c) actual costs for already approved HCFC consumption phase-down in the larger consuming Article 5 in the triennium 2012-2014, on the basis of an approved stage I HPMP (commitments as of ExCom 63);

(d) actual costs for the HCFC phase-down in the servicing sector in LVC countries via already approved HPMPs, with funding commitments in tranches, the last one being in 2020 (commitments as of ExCom 63).

(e) estimated costs for the HCFC phase-down in the production sector.

The above elements have been combined to determine the HCFC total funding requirements for each of the six different scenarios.

# 7 Funding Requirements for Non-HCFC ODS Phase-out and for Supporting Activities ODS for the 2012-2014 Replenishment Period and Beyond

## 7.1 ODS (non-HCFC) Phase-out Commitments

This chapter refers to the funding requirement for the phase-out of Methyl Bromide (MB) in six countries (Chile, China, Guatemala, Mexico, Vietnam and Yemen) and for the phase- out of ODS/CFC consumption in three Article 5 countries (DPR Korea, Eritrea and Iraq) during 2011 and 2012-2014. In the case of MB, there are no mandated reductions under the Montreal Protocol for Article 5 Parties until its complete phase-out in 2015.

It also relates to destruction projects, and the funding that that is expected to be required during the next triennium.

### *7.1.1 Methyl Bromide Phase-out*

Approved projects for the phase-out of MB in six countries require funding tranches of US$ 620,000 in 2011 and US$ 5,524,369 in the triennium 2012-2014, plus agency support costs of US$ 46,500 and US$ 475,212, respectively.

### *7.1.2 CFC Phase-out*

Three CFC phase-out plans still under implementation will require funding of US$ 963,000 in the period 2011-2014 (specifically the year 2011) with agency support costs of US$ 105,525.

### *7.1.3 Funding Requirement for the CFC and MB Production Sectors*

An accelerated production phase-out agreement with India was approved at the 54th Executive Committee meeting with a 2011 funding requirement of US$ 1,057,000. Agency support costs amount to an additional US$ 238,000.

The phase-out of MB production in China requires funding tranches of US$ 2,000,000 and US$ 1,790,000 in the years 2011 and 2014 excluding agency support costs of US$ 150,000 and US$ 134,250, respectively.

### *7.1.4 HPMP Preparation Costs*

HPMPs for stage II projects will have to be prepared in 2013-2014; these stage II projects will deal with additional reductions after the first (10 percent) reduction step in 2015. It will concern all those larger HCFC consuming countries that have received a “stage I approval”. It is estimated that some 60 countries will require stage II HPMPs from 2015 onwards. Funding at US$ 80,000 per HPMP preparation, at a total of US$ 4.8 million, will be required in the 2012-2014 triennium.

### *7.1.5 Institutional Strengthening*

From MLF Secretariat information the funding committed for IS projects in 2011-14 is US$ 9.414 million for the years 2011 and 2013, and US$ 6.929 million for the years 2012 and 2014, which yields a total of US$ 32.714 million for the four years concerned (US$ 0.914 million for Institutional Strengthening was approved at ExCom-63 and thus appears as an existing obligation. In the funding assessment it has been be subtracted from the US$ 9.414 million mentioned above).

Agency support costs of US$ 862,400 are included in this amount (with the exception of UNEP, that does not receive support cost for IS as it is covered by the CAP agreement).

The institutional strengthening funding has been determined on the basis that it will be provided through an independent project and not as part of an HPMP servicing plan. To date, very few Parties have elected to include IS funding in an HPMP.

### *7.1.6 ODS Destruction*

Interim guidelines for the funding of demonstration projects for ODS disposal of ODS were agreed by the Executive Committee at its 58th Meeting, in response to MOP decision XX/7. Between its 57th and 61st Meeting, the Executive Committee approved project preparation for such demonstration pilot projects for 15 countries; these countries were determined based on regional distribution[1]. Out of this project preparation funding, only three full demonstration projects have been submitted and approved by the Executive Committee at its 62nd and 63rd Meeting, and these are for Cuba (use of cement kilns for destruction), Ghana (destruction at an identified facility outside the country) and Mexico (destruction outside Mexico and exploring the use of carbon finance to sustain the project). The total funding that has been approved so far for the project preparation and the demonstration projects up to the 63rd Meeting is US$3.143 million (excluding agency support costs). At the 63rd Meeting, a window for ODS destruction/disposal projects for LVCs was agreed by the Executive Committee at an amount no more than US$ 3 million for 2011.

Given the above, it can be expected that nine full demonstration projects will be approved until the end of 2014 at a value of US$ 8.4 million with an additional US$ 0.6 million agency support costs (US$ 9 million in total).

[1] At the 59th Meeting of the Executive Committee, a project for demonstrating the use of mobile plasma destruction units was approved for Nepal, with the intention to explore the possibility of using these portable units for countries with very small waste ODS streams.

Funding for the triennium 2012-2014 is consistent with decisions taken by the Parties at their 20th and 21st MOP meetings and by the Executive Committee to fund relevant pilot destruction projects.

### *7.1.7 Technical Assistance*

For the replenishment period 2012-2014 technical assistance funding (which will be used for a variety of activities that fall outside the CAP program and other supporting activities) is estimated at a level of US$ 0.4 million.

## 7.2 The Funding Requirement for Supporting Activities

This chapter presents the funding requirements for supporting activities for the 2012-2014 triennium, classified as follows:
(1) UNEP's Compliance Assistance Programme (CAP);
(2) Core Unit funding for Implementing Agencies;
(3) Secretariat and Executive Committee; and
(4) Treasurer.

The replenishment period 2012-2014 is considered within the broader framework of a 4-year period starting in 2011 (as explained before).

### *7.2.1 The CAP; Personnel Costs, Clearing-house and Information Exchange Activities (UNEP)*

As an Implementing Agency of the Multilateral Fund, UNEP implements clearing-house and information exchange activities such as global information exchange, and the regional networking of National Ozone Officers. UNEP has brought its information dissemination, personnel, subcontract, training, equipment and premises components together in a "Compliance Assistance Programme", CAP. CAP has been functioning since the beginning of 2003.

For the year 2011 UNEP CAP costs are budgeted at US$ 10,019,000. The costs for 2011-14 amount to a total of US$ 41.917 million. This includes a growth of 3% per year, consistent with the limit specified by the Executive Committee. Agency support costs for the CAP are at a level of about 8%, i.e. US$ 3.11 million, and are included.

### *7.2.2 Core Unit Funding for the Implementing Agencies*

The current administrative cost regime provides for the staffing levels of UNDP, UNIDO and the World Bank to be maintained by core unit funding, which is additional to agency fees of 7.5% applied to projects with a cost of US$ 250,000 and above (including Institutional Strengthening and project preparation costs) and 9% for projects below US$ 250,000. The core unit costs were initially set at US$ 1.5 million for the World Bank and at US$ 1.7 million for UNDP and UNIDO, per year. Annual increases of 3% are normally approved. Core unit costs are therefore estimated at US$ 5.824

million for the year 2011 increasing to US$ 6.364 million in 2014, totalling US$ 24.366 million over the four-year period 2011-2014.

### *7.2.3 Operating Costs of the Executive Committee and the MLF Secretariat*

The funding required for the operating costs of the MLF Secretariat -- including the monitoring and evaluation task-- and the Executive Committee was determined through consultations with the MLF Secretariat regarding past operating budgets and the anticipated future workload. In principle, no major change is expected to the level of the operating budget except for providing for monetary inflation. For the costs of the MLF Secretariat and the Executive Committee an amount of US$ 6.334 million is estimated for the year 2011 and an amount of US$ 6.716 million in the year 2014, totalling US$ 26.092 million for the four-year period 2011-2014

### *7.2.4 Costs for the Treasurer*

The costs for the Treasurer are budgeted at US$ 0.5 million per year. This implies a funding requirement of US$ 2.0 million for the period 2011-2014.

## 7.3 Funding Requirement for IS and for Supporting Activities for the Periods 2015-2017 and 2018-20 (projections for the future beyond 2015)

### *7.3.1 IS*

The Institutional Strengthening component remains the same every two years if the funding is not changed by Executive Committee decisions. While there will be a funding review in this period, previous reviews have left funding levels unchanged. The indicative costs for 2015-2017 will therefore be US$ 25.757 million, and for the period 2018-2020, US$ 23.300 million.

### *7.3.2 Supporting Activities*

*UNEP Compliance Assistance Programme (CAP)*
The indicative allocations are: US$ 34.854million for the period 2015-17 with 8% support costs at US$ 2.42 million, and; US$ 38.086 million for the period 2018-20 with US$ 2.69 million support costs included.

*Agency Core costs*
Assuming the present funding arrangement continues, the replenishment for the Agency Core Unit costs for 2015-17 will be US$ 20.261 million and for 2018-2020 it will be US$ 22.139 million

*MLF Executive Committee and Secretariat costs*
Assuming a 3% increase annually, the need for the UNMLF Executive Committee and Secretariat costs for 2015-17 will be US$ 20.956 million and for 2018-2020 it will be US$ 22.226 million.

*Treasurer costs*

The current agreed costs for the treasurer of US$ 500,000 per year are not based on actual costs but are notional reimbursements to UNEP negotiated between UNEP and the Executive Committee. It is assumed that the costs of US$ 1.5 million for the treasurer will continue for the next two trienniums, i.e., the two replenishment periods 2015-2017 and 2018-2020.

***Table 7-1 Total costs for IS and for Supporting Activities for the periods 2011-2014, 2015-2017 and 2018-2020 based upon current agreed percentage growth for CAP and Core Unit (3%), stable biannual funding for Institutional Strengthening and non-changing costs for the Treasurer over the period 2011-2020.***

| Element | **2011-2014** | **2015-2017** | **2018-2020** |
|---|---|---|---|
| IS | 32.700 | 25.757 | 23.300 |
| **IS total** | **32.700** | **25.757** | **23.300** |
| | | | |
| CAP | 41.917 | 34.854 | 38.086 |
| Core Unit | 24.366 | 20.261 | 22.139 |
| ExCom and Secretariat | 26.092 | 20.956 | 22.226 |
| Treasurer | 2.000 | 1.500 | 1.500 |
| **Total** | **95.275** | **77.571** | **83.951** |

***** The agency support costs of 7.5-13% for Implementing Agencies and for Bilateral Agencies related to the individual Executive Committee approved and MLF funded activities are included in the ODS phase-out investment tables.

# 8 Total Funding Requirement

## 8.1 Introduction

Estimated requirements for individual expenditure categories other than HCFC phase-out (both consumption and production) were discussed in previous chapters (chapter 7). These requirements have been combined with HCFC phase-out estimates for the four-year period 2011-2014 (chapter 6), calculated for a total of six funding scenarios:

- three HCFC phase-down levels (10, 15 and 20% reduction from the baseline consumption) and, for each phase-out level,
- two reduction packages addressing different combinations of HCFC consumption in the foam, refrigeration and AC manufacturing and servicing sub-sectors (90-0-10% and 75-15-10% in ODP tonnes, respectively, see chapter 6).

This produces a total funding requirement for the four-year period 2011 to 2014. It includes actual project funding approved at the 63rd Executive Committee Meeting in April 2011. The funding for the triennium 2012-2014 is obtained by subtracting from the four-year figure the funding available for commitment in the remainder of 2011 according to the Consolidated Business Plan. After the conclusion of the third Executive Committee meeting for 2011, the triennium estimate can be automatically refined by subtracting from the four-year estimate the actual Fund expenditure for the balance of 2011, i.e. project and other expenditure approvals from the 64th and 65th Meetings.

The process assumes that any projects not approved in 2011 will be automatically transferred into the 2012-2014 triennium, together with their associated funding, which can and should occur. Accordingly, a discussion on carryover may not be required because any funding not approved in 2011 will automatically move to the next triennium, when it will be needed for the project for which it was allocated in 2011, to assist relevant Article 5 countries to meet their compliance obligations.

## 8.2 Funding requirement for the 2012-2014 triennium

Table 8-1 below, demonstrates the calculation of the total funding requirement for the "constant" part, i.e., the part not related to the funding of HCFC consumption and production phase-out. The contents of Table 8-1 are as follows:

- Funding commitments already approved by the Executive Committee for both the remainder of non-HCFC phase-out, including methyl bromide consumption and production
- Funding estimated for destruction projects
- Estimated project preparation funding for stage II HPMPs

- Existing commitments for HCFC phase-out approved prior to 2011 and at the 63rd Executive Committee meeting,
- Funding for Institutional Strengthening including approvals at the 63rd Executive Committee meeting
- Other non-investment funding estimated on the basis of current practice (see Chapter 7)

***Table 8-1 Elements that determine the 2011-2014 total funding requirement (US$ million)****

| **Funding Elements for 2011- 2014** **(***including agency support costs where appropriate)* | **(US$ million)** |
|---|---|
| Commitments for non-HCFC phase-out | 2.36 |
| Commitments for MeBr phase-out in consumption and production | 10.74 |
| Destruction | 9.00 |
| Preparation of stage II HPMPs | 4.80 |
| Existing commitments for HPMPs (for LVCs and non-LVCs) and individual HCFC phase-out projects | 40.8 |
| Technical Assistance (TAS) | 0.4 |
| Institutional Strengthening | 32.7 |
| *Other non-investment funding for 2011-2014:* | |
| -CAP | 41.92 |
| -Agencies' Core Unit Costs | 24.37 |
| -Secretariat | 26.09 |
| -Treasurer | 2.00 |
| **Subtotal** | **195.2** |
| **Plus new HPMPs** | **Funding requirements as per scenarios in Table 8-2** |
| **Plus production sector closure costs** | **Funding requirements as per scenarios in Table 8-2** |

Note *: based on actual approvals at the 63rd meeting plus anticipated approvals for the remainder of 2011 as per the Consolidated Business Plan, plus Task Force estimates for 2012-2014.

To obtain the triennium funding requirement 2012-2014 it is necessary to deduct from the four-year estimate 2011-2014 the balance of funding remaining available for commitment in 2011. This is demonstrated in Table 8-2 below for each of the six scenarios studied. The table presents the estimated costs under each scenario for new HPMPs, HCFC-141b/142b production closure, HCFC-22 production closure and the established costs as indicated in Table 8-1 (constant for each scenario). These costs are added to give a total 4-

year funding requirement for each scenario. From each of these 4-year scenario totals is deducted the funding available for the balance of 2011, after taking account of all approvals at the 63rd Meeting, as provided by the Fund Secretariat. This amount is also constant for each scenario. The estimated funding requirement for each scenario appears in the final column of Table 8-2.

***Table 8-2 Total funding requirement for the triennium 2012-2014 for six scenarios, (three baseline consumption reduction levels (in percentages, ODP tonnes) and two sub-sector reduction packages) (US$ million)***

| **Reduc-tion from baseline** | **Assessed costs for the 4-year period 2011-2014** | | | | | Planned funding available for the balance of 2011 | **Funding requirmt for triennium 2012-2014 for each scenario** |
|---|---|---|---|---|---|---|---|
| | New HPMPs | Production Closure HCFC-141b/-142b | Production Closure HCFC-22 | Established costs from Table 8-1b | **Total 4-year funding requirement per scenario** | | |
| | **Sub-sector reduction package 75-15-10%** | | | | | | |
| **10%** | 240.7 | 65.0 | 57.6 | 195.2 | 558.8 | (252.7) | **306.1** |
| **15%** | 354.6 | 97.0 | 84.2 | 195.2 | 734 | (252.7) | **481.3** |
| **20%** | 471.3 | 129.0 | 110.7 | 195.2 | 906.2 | (252.7) | **653.5** |
| | **Sub-sector reduction package 90-0-10%** | | | | | | |
| **10%** | 190.3 | 77.7 | 34.7 | 195.2 | 497.9 | (252.7) | **245.2** |
| **15%** | 277.9 | 116.0 | 49.7 | 195.2 | 638.8 | (252.7) | **386.1** |
| **20%** | 367.6 | 154.4 | 64.8 | 195.2 | 782 | (252.7) | **529.3** |

## 8.3 Consideration of the Six Scenarios

In the HPMPs so far approved by the Executive Committee, the proportion of baseline consumption funded for phase out in the project has varied widely. Only two out of ten non-LVC countries have sought funding for the minimum of 10 percent of baseline consumption. The HPMP for one non-LVC country includes funding to phase out consumption equivalent to 63 percent of its baseline. In HPMPs so far funded for non-LVC countries the average level of funded consumption exceeds 20 percent. The Executive Committee is considering HPMPs on their individual merits. While the number so far approved for non-LVC countries is still low, amounting to some 10 projects Rather than the reduction being dependent on the sub-sectoral composition, it appears that the percentage reduction being approved is related principally to the cost effectiveness realised in the project, as a result of the scale of the manufacturing operations and the relative sizes of the sub-sectors in the country concerned.

These uncertainties, together with the small sample of non-LVC HPMPs approved to date do not provide an adequate basis for a quantitative assessment of likely funding levels within the range created by the six scenarios. However it is possible to make qualitative observations.

The use of funded phase-out reduction percentages varying from 10 to 20% is based on a number of considerations. Firstly, the Montreal Protocol 10 percent reduction step defines the minimum requirement for funded phase-out. Many of the larger consuming countries with HCFC-based manufacturing activities are experiencing industrial expansion in these sectors which will need to be curtailed or converted to enable compliance with the freeze in 2013. Secondly, the Executive Committee has generally approved reductions of 10-35 percent to date, dependent on cost effectiveness. Thirdly, assessments that would be based on funding reductions of 30 percent in the stage I HPMPs and standard cost effectiveness values as derived in this study, together with corresponding reductions in the production sector, would result in a total annual funding requirement in the order of US$ 800 million, far beyond what has so far been allocated, implemented and disbursed, in any previous triennium.

The assessment of 15 percent as a mid-point percentage for both sub-sector divisions scenario carries two important qualifications. As indicated above, so far a relatively small number of large investment projects and HPMPs for larger consuming countries has been approved.

Additionally, the reductions (from the baseline) of 20 percent and larger were generally approved in circumstances where the country concerned had been in a position to offer consumption reductions that were substantially less costly than specified by the cost effectiveness thresholds (as indicated in Chapter 4), for instance they were realised mostly in one major industry that was converted, and/or under circumstances where foreign ownership resulted in a substantial proportion of the phase-out cost not being eligible for funding.

Taking the above into consideration, a prudent course of action would be to acknowledge that future HPMPs (no further stand alone projects are to be submitted) could be based on a level of phase-out consistent with that in projects so far approved, that is, of the order of 15-30 percent, but to acknowledge that the cost-effectiveness of these projects may give rise to lower project costs than those resulting from a purely technical analysis. The corollary would also apply. Specifically, for projects that may be approved for lower levels of phase-out, approaching the minimum of 10 percent of the baseline, it would be expected that their cost effectiveness would give rise to higher project costs than predicted from a technical analysis.

For the above reasons, there are qualitative grounds for suggesting that the most likely funding outcome, comprising funding for both consumption reduction and production closure could lie in the mid-range of the scenarios presented. ***For instance, the average of the two scenarios with different reduction package compositions for a 15 percent funded reduction from the***

***baseline, with a 10% spread, would yield the range of US$ 390.2-477.0 million for the triennium 2012-2014.***

However, these figures are very much dependent on the eventual HCFC production plant closure funds that might be approved and disbursed in the triennium 2012-2014.

As indicated in Table 8-3 below, production closure costs for each of the six scenarios range from 38 percent to 46 percent of the total funding requirement.

***Table 8-3 2012-2014 HCFC production closure funding for six scenarios as a proportion of total funding requirement***

| Reduction to 2013 baseline and to further reductions from baseline as indicated | Total Funding requirement for triennium 2012-2014 (from Table 8.3) | HPMPs. other ODS, non-investment and supporting costs | HCFC production closure costs | |
|---|---|---|---|---|
| | | | In US$ millions | As a percentage of Total Funding Requirement |
| **Sub-sector reduction 75-15-10%** | | | | |
| **10%** | **306.1** | 183.5 | 122.6 | 40.1 |
| **15%** | **481.3** | 362.4 | 181.2 | 37.6 |
| **20%** | **653.5** | 413.8 | 239.7 | 36.6 |
| **Sub-sector reduction 90-0-10%** | | | | |
| **10%** | **245.2** | 132.8 | 112.4 | 45.8 |
| **15%** | **386.1** | 220.4 | 165.7 | 42.9 |
| **20%** | **529.3** | 306.1 | 223.2 | 42.1 |

While, as previously indicated, the Task Force has no guidance or data on which to base a production sector analysis, there would appear to be opportunities for producers to arrange their industrial activities, for example through increased diversion of production to feedstock uses, to mitigate or avoid the need for early closure of plants.

The anticipated approval of a significant number of HPMPs for larger consuming countries at the two Executive Committee meetings remaining for this year, possible including the largest consuming country, China, can be expected to provide a substantial amount of additional reference data and therefore add to the certainty of estimations.

Estimates for funding requirements are based on the actual costs incurred and year 2011 prices.

## 8.4 Funding Requirement for Subsequent Triennia

Indicative funding requirements for the triennia 2015-2017 and 2018-2020 have also been determined as requested in the Terms of Reference. Table 8-4 below gives the calculation of the total funding requirement for the period 2015-2017, Table 8-5 for 2018-2020. The contents of Tables 8-4 and 8-5 are as follows:

1. Estimated funding requirements for HCFC phase-out via HPMPs for LVCs
2. Funding estimated for destruction projects
3. Funding for Institutional Strengthening after ExCom-63
4. Non-investment funding estimated on the basis of current practices (see Chapter 7)
5. Estimates for the cost of stage II HPMPs for large consuming countries and for commitments for HPMPs for LVCs approved after ExCom-63
6. Production closure funding for HCFC-141b/-142b and HCFC-22
7. Totals for all elements for two subsector reduction packages (75-15-10 and 90-10)
8. Average of the two values

***Table 8-4 Elements that determine the 2015-2017 total funding requirement (US$ million) for two scenarios related to the subsector reduction package***

| **Funding Requirement for the period 2015-2017** | | **US$ million** |
|---|---|---|
| Existing Commitments HPMPs (for LVCs and non-LVCs) | | 9.75 |
| Destruction | | 0 |
| Institutional Strengthening after ExCom-63 | | 25.76 |
| *Non-investment funding for 2015-2017:* | | |
| -CAP | | 37.27 |
| -Core | | 20.26 |
| -Secretariat | | 20.96 |
| -Treasurer | | 1.50 |
| | | |
| HPMPs new for large countries | 75-15-10 reduction package | 90-0-10 reduction package |
| HPMPs stage II | 395.6 | 297.0 |
| Production closure HCFC-141b/-142b | 96.0 | 115.2 |
| Production closure HCFC-22 | 79.5 | 45.2 |
| **TOTAL** | **686.6** | **572.9** |
| (average) | | 629.8 |

In the period 2015-2017, the remaining payments for HPMPs for LVC countries that were approved in 2011-2012 decrease significantly compared to the period 2011-2014 (from about 27 to 9 million). This also applies for the

triennium 2018-2020 where the costs for LVCs further decrease to US$ 3.44 million. This is because the funding disbursement schedules yields smaller amounts for later years.

For all funding elements other than stage II HPMPs, and assuming that the baseline consumption has been achieved in 2015 for all countries, the total funding requirement for the period 2015-2017 would consist of four elements namely: (1) existing commitments, (2) institutional strengthening, (3) non-investment funding, (4) production closure costs and (5) destruction project funding (the zero value assumed in Table 8-4 is reflecting decisions taken by the Parties at their 20th and 21st Meetings and decisions taken by the Executive Committee at their 60-62nd meetings for the triennium 2012-2014, where it concerns addressing funding of pilot projects under the Multilateral Fund. There is no policy guidance available to provide a basis for funding in subsequent triennia after 2012-2014).

For the two funding scenarios with different reduction packages, it is assumed that countries can submit requests for the funding of stage II HPMPs in the year 2015 (or in the year 2014 for the year 2015 and beyond). At present the Executive Committee has no rules or policies contrary to this position, even when the approved project funding in the period 2011-2014 accommodates a phase-out of more than a 10% reduction from the baseline.

It is also assumed that projects in this category will again be considered by the Executive Committee individually on their merits.

For the period 2015-2017 one scenario for the reduction has been considered, i.e., a 15% further reduction during those three years, together with two reduction packages that consist of 75% foam, 15% RAC manufacturing and 10% servicing, as well as 90% foam and 10% servicing. These packages have been maintained for all countries, even those for which there may be difficulties in identifying enough foam operations to support the 90% foam scenario in this triennium. In these scenarios the cost effectiveness values used are those established in this report which accommodate significant numbers of low GWP conversions.

The funding requirement consists of amounts of US$ 395.6 and 297.0 million for stage II HPMPs for the two subsector divisions, HPMP commitments from 2011-2012 of US$ 3.3 million and assumed costs for HCFC phase-down in production (closure compensation) of US$ 175.5 and 160.4 million for the two scenarios. Agency support costs are included in each item as appropriate. The total is determined at US$ 686.6 and 572.9 million; one might consider the average value of US$ 629.8 million.

It might be expected that in the triennium 2015-2017 additional RAC manufacturing would need to be addressed in the HPMP, giving a higher average cost-effectiveness. However, costs for RAC are likely to have

decreased due to the availability of more mature and more cost effective low-GWP solutions.

Furthermore more investment will be needed in the servicing sector at a cost of US$ 4.5 per kg phased-out. Both effects are difficult to estimate; it is therefore difficult to present a sensitivity analysis at this stage.

***Table 8-5 Elements that determine the 2018-2020 total funding requirement (US$ million) for two scenarios related to the subsector reduction package***

| **Funding Requirement for the period 2018-2020** | | **US$ million** |
|---|---|---|
| Existing Commitments HPMPs (for LVCs and non-LVCs) | | 3.44 |
| Destruction | | 0 |
| Institutional Strengthening after ExCom-63 | | 23.30 |
| *Non-investment funding for 2018-2020:* | | |
| -CAP | | 40.78 |
| -Core | | 22.14 |
| -Secretariat | | 22.23 |
| -Treasurer | | 1.50 |
| | | |
| HPMPs new for large countries | 75-15-10 reduction package | 90-0-10 reduction package |
| HPMPs stage II | 430.3 | 321.5 |
| Production closure HCFC-141b/-142b | 105.6 | 126.8 |
| Production closure HCFC-22 | 126.8 | 49.7 |
| **TOTAL** | **776.1** | **611.4** |
| (average) | | 693.7 |

Existing HPMP commitments in the period 2018-2020 are reduced to US$ 3.44 million. The funding requirement consists of amounts of US$ 430.3 and 321.5 million for stage II HPMPs for the two subsector divisions, and for HCFC phase-down in production (closure compensation) costs are assumed at of US$ 232.4 and 176.5 million for the two subsector division scenarios (75-15-10 and 90-10). Agency support costs are included in each item as appropriate. The total is determined at US$ 776.1 and 611.4 million; one might consider the average value of US$ 693.7 million.

For the 15 percent baseline reduction case given in Table 8-2 one can calculate an average value for the two subsector reduction packages. This amounts to US$ 439.9 million. Similar average values for the two subsequent triennia 2015-2017 and 2018-2020 are given in Tables 8-4 and 8-5. These average values are presented in Table 8-6, together with the average overall triennium funding.

Table 8-6 also indicates the corresponding values for the same combination of scenarios but incorporating a hypothetical case in which production closure costs are halved to US$ 1.50 per kg.

***Table 8-6 Funding requirement for three triennia using the 15 % baseline reduction case and the average of the two subsector reduction packages (US$ million)***

| **Production closure** | **Triennium 2012-2014** | **Triennium 2015-2017** | **Triennium 2018-2020** | (Average funding per triennium) |
|---|---|---|---|---|
| US$ 3.0 per kg | 439.9 | 629.8 | 693.7 | 587.8 |
| US$ 1.5 per kg | 403.0 | 545.7 | 591.1 | 513.3 |

It needs to be underlined that the lower funding requirement for the triennium 2012-2014 is due to the high level of funding available in 2011 for stage I HPMPs, that the amounts for the triennium 2015-2017 concern a further 15% HCFC consumption reduction, and that the amount for the triennium 2018-2020 concerns a 16.5% consumption reduction (due to the higher annual reduction percentage required under the Montreal Protocol reduction schedule from the beginning of 2020 onwards).

Using the closure costs of US$ 3.00 per kg adopted for this analysis the average replenishment level across the three triennia is US$ 587.8 million. This value would decrease by US$ 75.4 million to US$ 513.3 million if the production closure funding was halved. Although this would give a stable profile, it would still imply a considerably higher level of replenishment than agreed previously for any triennium.

While the Task Force cannot further elaborate on these values at this stage, it may be useful to consider a wider variety of production closure funding scenarios in further studies once additional information and data becomes available.

In all the calculations presented above, the same non-eligible foreign ownership and export and non-eligible proportions have been applied in each of the triennia.

# 9 Concluding Remarks

## 9.1 Funding Estimates

The TEAP Replenishment Task Force prepared this report on the funding requirement for the 2012-2014 replenishment in accordance with Decision XXII/3 of the Twenty-second Meeting of the Parties.

It estimates the funding required to enable the Article 5 Parties to comply with specifically the control measures for Annex C substances (HCFCs). The total funding requirement was determined by the sum of the estimates for the following cost elements:

a) forward commitments from approved investment projects in the consumption sector, including HCFC projects (in both LVCs and non-LVCs)

b) a large number of new activities in the HCFC consumption sector, determined via a spreadsheet analysis by the Task Force

c) future commitments from closure projects in the production sector, specifically for HCFC-141b, -142b and HCFC-22, based upon consumption reduction estimates

d) costs for destruction projects

e) funding for Institutional Strengthening

f) supporting activities, including costs for the CAP programme, Core Unit funding for the Implementing Agencies, operating costs of the MLF Secretariat and Executive Committee and the costs for the Treasurer

The cost estimates for HCFC consumption phase-out plans (stage I HPMPs) for the period mid-2011 (after ExCom-63) through 2014 were based on a mathematical analysis of six scenarios involving estimates for approvals of reductions in HCFC consumption towards the year 2015 and the composition and cost-effectiveness of those reductions determined at the sub-sector level. Three scenarios directly deal with the level of consumption reductions that might be funded up to 2014; two other scenarios examine different cost-effectiveness factors, i.e., they examine different packages for HCFC reductions in the foam subsectors (PU and XPS foam), and in refrigeration and air-conditioning manufacturing and servicing.

The study is based on all relevant decisions of the Executive Committee and the Meetings of the Parties, and on consultations with the MLF Secretariat, the Ozone Secretariat, the Implementing Agencies, and several members of the 2010 and 2011 Executive Committees, as well as other Parties.

## 9.2 Parameters and scenarios

HCFC consumption data up to 2009 is known from Article 7 reporting to the Ozone Secretariat. But a number of parameters had to be estimated:

- The freeze (baseline) level, which is based upon the HCFC consumption for 2009 and 2010; consumption in 2010 was estimated to be 8% larger than consumption in 2009;
- Funding of different levels of HCFC phase-out; since the Executive Committee has approved funding for phase-out of amounts from 10% to over 25% of the estimated baseline, several consumption reductions were investigated (10%, 15% and 20% of the baseline);
- Costs (in US$ per metric kg) for the phase-out of HCFCs in the foam sub-sector were estimated on the basis of technical analysis and were compared to experience arising from Fund rules and policies and costs in relevant approved projects; cost effectiveness values for the RAC sub-sector were determined on the basis of technical analysis and best estimates for the commercial refrigeration and air-conditioning sectors.

The Task Force grouped Article 5 Parties as follows, according to 2009/2010 estimated baseline (freeze) levels:

- One country (China), with a consumption in the order of 300,000 tonnes;
- 33 countries with a consumption between 1000 and 20,000 tonnes, with, in most cases, very significant HCFC-141b/142b consumption;
- 25 countries with a consumption between 360 and 1000 tonnes, with a small consumption of HCFC-141b in the total or consumption of HCFC-22 only;
- 86 countries with a consumption of up to 360 tonnes, this being HCFC-22 consumption for servicing only.

The relative contribution of the groups to the total HCFC consumption make it clear that consumption reductions for the Parties in Groups 3 and 4 will have a relatively small impact on the funding calculations. Conversely, the level of consumption in China will result in China's HPMP and production sector plan having a significant influence on the overall funding requirements for the triennia under consideration. This is an important issue to take into account when considering the different funding requirement values presented in chapter 8. The Task Force has applied similar technical criteria in its analysis of HCFC funding scenarios for China and for the other larger consuming countries. No attempt has been made to assess possible outcomes arising from the negotiation process.

*Three parameters have a key impact on calculation of the triennia funding requirements: (1) the percentage of funded reductions from the baseline, (2) the share of the reductions attributed to the different technology sub-sectors in combination with cost-effectiveness values, and (3) the costs for production*

*closure for all HCFCs (combined with estimates of when these funds would be disbursed).*

## 9.3 Funding requirement and cost effectiveness

Calculation of the funding requirement for the triennium 2012-2014 yields a wide spread in values dependent on the scenario chosen. On one hand, it varies from US$ 305 to 653 million for one sub-sector reduction package for funded reductions from the baseline consumption of between 10 percent and 20 percent. On the other, it varies from US$ 244 to 529 million for a different sub-sector reduction package, for the same set of funded reductions from the baseline. The Task Force has not undertaken further quantitative analysis to refine this range of values in the absence of more comprehensive data on project funding outcomes. However, qualitative remarks have been provided on the likelihood of a mid-range outcome of US$ 390- 477 million for the first triennium.

The cost effectiveness values for the commercial refrigeration and air conditioning sector have been derived on the basis of the estimated level of penetration of the different alternatives, considerations of incremental capital and operating costs, and increases of maximum 25% of the cost effectiveness for low-GWP conversions. The following comments apply to the cost effectiveness values for these sub-sectors:

- There are a large number of refrigerant options that can currently be applied to systems to replace HCFCs, which include a variety of low-GWP alternatives. Both the current and longer term options for all sectors include HFCs, unsaturated HFCs, blends of HFCs and unsaturated HFCs, hydrocarbons, carbon dioxide and ammonia.
- Many of the low-GWP options are subject to hindrances associated with their application, including flammability, higher toxicity, cost and the maturity of the technology. In particular, the applicability of, and the technical matters associated with, the options for use of unsaturated HFCs and unsaturated HFC/HFC blends are as yet largely unknown, so the estimated costs for these technologies are less certain.
- The potential penetration of the low-GWP options on both a technical and cost basis varies between 5% and 30% depending upon the sub-sector at the present time, and by over 70% for the longer-term.
- The analysis of the cost-effectiveness of the various options is subject to a substantial level of uncertainty for a variety of technical reasons. There is also a wide variation between different technical options within a particular sub-sector and for the same option in different sub-sectors.
- In general, the cost-effectiveness values arising from the technical analysis exceed the threshold values included in decision 60/44. This is particularly relevant for some of the low-GWP options and especially for commercial refrigeration. This could occur in part because of the difference between

total conversion costs at an enterprise level and eligible incremental costs calculated according to Multilateral Fund rules and practices.

- Based on the potential level of penetration of the technology, the technical cost effectiveness values for each sub-sector and the corresponding options, combined cost-effectiveness values have been estimated for two scenarios: one where standard (high-GWP) options are used and one where low-GWP options are used wherever possible. These cost-effectiveness values may be considered as the upper and lower bounds. It can be seen that at present there is disagreement between the costs of using low-GWP options and the funding available via threshold values.
- It should be noted that the 90%-0%-10% sub-sector reduction package probably represents the cheapest option for climate benefits in the short term, since this avoids the potentially high future emissions due to servicing needs of RAC equipment, the production of which would otherwise be in many of the cases converted to high-GWP technology (especially considering the established growth rates).

## 9.4 Achieving stable funding

The funding requirements for the three triennia, spanning 2012 to 2020, show a clearly increasing trend. The average values derived in Chapter 8 indicate the third triennium exceeding the first by some US$ 250 million.

The lower funding requirement for the triennium 2012-2014 is due in part to:

- the high level of funding remaining available in 2011 for stage I HPMPs
- funding levels for the triennia 2015-2017 and 2018-2020 being required to support increasing rates of reductions in HCFC consumption:
    - 15 percent in the 2015-2017 triennium compared to 10 percent in 2012-2014
    - 16.5 percent in the 2018-2020 triennium (due to the higher annual reduction percentage required under the Montreal Protocol reduction schedule from the beginning of 2020 onwards).

Several options could assist in re-balancing the funding requirements between the triennia. The first is to increase the relevant cost-effectiveness threshold values in the analysis, thus permitting the funding of an increased proportion of (more costly) low-GWP technologies. However in the short term the increased take-up of low-GWP solutions at the country level faces a number of practical challenges additional to the level of funding available.

Consideration could also be given to encouraging the funding of higher levels of phase-out commitments in the first triennium in new stage I HPMPs for

larger consuming countries. While funded phase-out in approved HPMPs has exceeded 30 percent, phase-out commitments contained in them have more generally been confined to meeting the 10 percent reduction step by 2015. Conversely, the succeeding triennia will need to address higher levels of reductions as indicated above. The Task Force notes that the increased cost of future stage I HPMP projects for larger consuming countries, should they be designed to achieve permanent reductions in consumption greater than the 10 percent first reduction step, would contribute to an increased requirement for funds in the first triennium and a corresponding reduction in funding requirements in the second and/or third triennia. Most stage I HPMPs for larger consuming countries are already being prepared. Nonetheless, there could be benefits in examining options for increasing the phase-out targets contained in them.

Production closure funding has a significant influence on overall replenishment levels and on the distribution of funding allocations between triennia. In the triennium 2012-2014 the funds estimated for production closure constitute between 37 and 46 percent of the total funding requirement. Production sector estimates are at this stage based on a funding comparison with CFC plant closures and pro-rata reductions in the consumption sector.

The average value of the overall triennium funding requirement for the mid-point case examined in Chapter 8 is US$ 588 million. This value would decrease by US$ 75 million if the production closure funding was halved (using a value of US$ 1.5 per kg instead of the US$ 3.0 per kg used in this study). Although providing a stable profile around US$ 500 million, it would still imply new funding levels per triennium greater than any previously agreed.

The Task Force cannot further elaborate on production sector needs at this stage. The availability of additional information about the structure and organisation of the industry, especially with regard to feedstock uses, the production sector technical audit for China, and the development of additional guidance by the Executive Committee's Production Sector Working Group, will facilitate a more comprehensive examination of production sector funding requirements and the future refinement of triennia estimates. The development of production closure projects (with funding expenditure) in the first triennium would appear to require some priority, both to support reductions in the consumption sector and to avoid greater imbalances in triennia funding requirements. It may be useful to consider a wider variety of production closure funding scenarios in future studies.

# 10 Acronyms

| | |
|---|---|
| CE | Cost Effectiveness |
| HPMP | HCFC Phase-out Management Plan |
| MLFS | Multilateral Fund Secretariat |
| LVC | Low Volume Consuming Country |
| RAC | Refrigeration and Air Conditioning |
| TEAP | Technology and Economic Assessment Panel |

# 11 References


/RTOC10/ 2010 Assessment Report of the Refrigeration, AC and Heat Pumps Technical Options Committee, http://ozone.unep.org/teap/Reports/RTOC/index.shtml

/UNEP08/ Assessment of the Funding Requirement for the Replenishment of the Multilateral Fund 2009-2011, TEAP Replenishment Task Force Report, May 2008

/UNEP11/ United Nations Environment Programme, Data reported under Article 7 for Production, Feedstock, Exports, etc., Communications via Gerald Mutisya, UNEP Nairobi, Compilations by RTF Co-chair Kuijpers

# Annex 1 Country Groups and Decision 60/44

## A1.1 Article 5 countries as subdivided in 4 groups

| | ODS Consumption in ODP Tonnes | | | |
|---|---|---|---|---|
| | Annex C, Group I (HCFCs) | | | |
| | Party | 2009 | 2010 | Baseline |
| GROUP 1 | | | | |
| 1 | China | 18,602.7 | 20,090.9 | 19,346.8 |
| GROUP 2 | | | | |
| | Republic of Korea | 1,768.9 | 1,910.4 | 1,839.7 |
| 2 | India | 1,598.7 | 1,726.6 | 1,662.6 |
| 3 | Brazil | 1,415.5 | 1,528.7 | 1,472.1 |
| 4 | Saudi Arabia | 1,362.0 | 1,471.0 | 1,416.5 |
| 5 | Mexico | 1,125.9 | 1,216.0 | 1,170.9 |
| 6 | Thailand | 826.6 | 892.7 | 859.7 |
| 7 | Turkey | 609.9 | 658.7 | 634.3 |
| | United Arab Emirates | 530.5 | 572.9 | 551.7 |
| 8 | Malaysia | 494.0 | 533.5 | 513.8 |
| 9 | Kuwait | 398.1 | 429.9 | 414.0 |
| 10 | Egypt | 396.6 | 428.3 | 412.5 |
| 11 | Indonesia | 374.8 | 404.8 | 389.8 |
| 12 | Nigeria | 370.0 | 399.6 | 384.8 |
| 13 | South Africa | 339.2 | 366.3 | 352.8 |
| 14 | Argentina | 326.1 | 352.2 | 339.1 |
| 15 | Iran (Islamic Republic of) | 312.4 | 337.4 | 324.9 |
| 16 | Pakistan | 239.8 | 259.0 | 249.4 |
| | Singapore | 226.0 | 244.1 | 235.0 |
| 17 | Venezuela (Bolivarian Republic of) | 216.2 | 233.5 | 224.8 |
| 18 | Colombia | 209.7 | 226.5 | 218.1 |
| 19 | Viet Nam | 207.5 | 224.1 | 215.8 |
| 20 | Philippines | 194.7 | 210.3 | 202.5 |
| 21 | Syrian Arab Republic | 147.2 | 159.0 | 153.1 |
| 22 | Iraq | 111.0 | 119.9 | 115.4 |
| 23 | Cameroon | 104.2 | 112.5 | 108.4 |
| 24 | Libyan Arab Jamahiriya | 97.5 | 105.3 | 101.4 |
| 25 | Democratic Republic of the Congo | 85.7 | 92.6 | 89.1 |
| 26 | Qatar | 79.7 | 86.1 | 82.9 |
| 27 | Ghana | 77.3 | 83.5 | 80.4 |
| 28 | Chile | 75.2 | 81.2 | 78.2 |
| 29 | Jordan | 70.9 | 76.6 | 73.7 |
| 30 | Morocco | 68.0 | 73.4 | 70.7 |
| 31 | Bangladesh | 67.7 | 73.1 | 70.4 |
| 32 | Democratic People's Republic of Korea | 61.8 | 66.7 | 64.3 |
| 33 | Côte d'Ivoire | 61.7 | 66.6 | 64.2 |
| 34 | Lebanon | 58.4 | 63.1 | 60.7 |
| | TOTAL | 14,709.4 | 15,886.2 | 15,297.8 |
| | TOTAL - Korea/Singapore/UAE | 12,184.0 | 13,158.7 | 12,671.4 |
| GROUP 3 | | | | |
| 35 | Kenya | 54.7 | 59.1 | 56.9 |
| 36 | Sudan | 50.6 | 54.6 | 52.6 |
| 37 | Dominican Republic | 48.5 | 52.4 | 50.4 |
| 38 | Bahrain | 45.1 | 48.7 | 46.9 |
| 39 | Somalia | 44.9 | 48.5 | 46.7 |
| 40 | Tunisia | 44.3 | 47.8 | 46.1 |
| 41 | Trinidad and Tobago | 38.0 | 41.0 | 39.5 |
| 42 | Niger | 36.3 | 39.2 | 37.8 |
| 43 | Senegal | 34.8 | 37.6 | 36.2 |
| 44 | Madagascar | 33.0 | 35.6 | 34.3 |
| 45 | Oman | 30.7 | 33.2 | 31.9 |
| 46 | Algeria | 30.2 | 32.6 | 31.4 |
| 47 | Gabon | 29.7 | 32.1 | 30.9 |
| 48 | Peru | 27.3 | 29.5 | 28.4 |
| 49 | Burkina Faso | 26.7 | 28.8 | 27.8 |
| 50 | Chad | 26.0 | 28.1 | 27.0 |
| 51 | Panama | 25.0 | 27.0 | 26.0 |
| 52 | Benin | 23.6 | 25.5 | 24.5 |
| 53 | Afghanistan | 22.2 | 24.0 | 23.1 |
| 54 | Uruguay | 22.0 | 23.8 | 22.9 |
| 55 | Guinea | 21.8 | 23.5 | 22.7 |
| 56 | Ecuador | 20.7 | 22.4 | 21.5 |
| 57 | Mauritania | 20.4 | 22.0 | 21.2 |
| 58 | Angola | 19.3 | 20.8 | 20.1 |
| 59 | Togo | 19.3 | 20.8 | 20.1 |
| | TOTAL | 795.1 | 858.7 | 826.9 |

| | | | | |
|---|---|---|---|---|
| 60 | Jamaica | 18.2 | 19.7 | 18.9 |
| 61 | Honduras | 17.8 | 19.2 | 18.5 |
| 62 | Cambodia | 17.1 | 18.5 | 17.8 |
| 63 | Paraguay | 15.1 | 16.3 | 15.7 |
| 64 | Mali | 14.4 | 15.6 | 15.0 |
| 65 | Costa Rica | 14.2 | 15.3 | 14.8 |
| 66 | Equatorial Guinea | 13.9 | 15.0 | 14.5 |
| 67 | Sri Lanka | 13.4 | 14.5 | 13.9 |
| 68 | Zimbabwe | 12.4 | 13.4 | 12.9 |
| 69 | Central African Republic | 11.9 | 12.9 | 12.4 |
| 70 | El Salvador | 11.9 | 12.9 | 12.4 |
| 71 | Cuba | 11.7 | 12.6 | 12.2 |
| 72 | Botswana | 11.0 | 11.9 | 11.4 |
| 73 | Mauritius | 10.7 | 11.6 | 11.1 |
| 74 | Lesotho | 10.3 | 11.1 | 10.7 |
| 75 | Congo | 9.7 | 10.5 | 10.1 |
| 76 | Guatemala | 9.4 | 10.2 | 9.8 |
| 77 | Swaziland | 9.2 | 9.9 | 9.6 |
| 78 | Serbia | 9.0 | 9.7 | 9.4 |
| 79 | Malawi | 8.6 | 9.3 | 8.9 |
| 80 | Fiji | 7.6 | 8.2 | 7.9 |
| 81 | Burundi | 6.9 | 7.5 | 7.2 |
| 82 | Turkmenistan | 6.9 | 7.5 | 7.2 |
| 83 | Armenia | 6.8 | 7.3 | 7.1 |
| 84 | Bosnia and Herzegovina | 6.0 | 6.5 | 6.2 |
| 85 | Namibia | 6.0 | 6.5 | 6.2 |
| 86 | Nicaragua | 6.0 | 6.5 | 6.2 |
| 87 | Albania | 5.4 | 5.8 | 5.6 |
| 88 | Maldives | 5.1 | 5.5 | 5.3 |
| 89 | Liberia | 5.0 | 5.4 | 5.2 |
| 90 | Croatia | 4.6 | 5.0 | 4.8 |
| 91 | Georgia | 4.6 | 5.0 | 4.8 |
| 92 | Barbados | 4.5 | 4.9 | 4.7 |
| 93 | Brunei Darussalam | 4.5 | 4.9 | 4.7 |
| 94 | Bolivia | 4.4 | 4.8 | 4.6 |
| 95 | Kyrgyzstan | 4.4 | 4.8 | 4.6 |
| 96 | Mozambique | 4.3 | 4.6 | 4.5 |
| 97 | Myanmar | 4.1 | 4.4 | 4.3 |
| 98 | Sao Tome and Principe | 4.1 | 4.4 | 4.3 |
| 99 | The Former Yugoslav Republic of Macedonia | 4.0 | 4.3 | 4.2 |
| 100 | Rwanda | 3.8 | 4.1 | 4.0 |
| 101 | Azerbaijan | 3.5 | 3.8 | 3.6 |
| 102 | Bahamas | 3.5 | 3.8 | 3.6 |
| 103 | Papua New Guinea | 3.2 | 3.5 | 3.3 |
| 104 | Suriname | 2.7 | 2.9 | 2.8 |
| 105 | Tajikistan | 2.6 | 2.8 | 2.7 |
| 106 | Belize | 2.5 | 2.7 | 2.6 |
| 107 | Haiti | 1.9 | 2.1 | 2.0 |
| 108 | Cape Verde | 1.8 | 1.9 | 1.9 |
| 109 | Solomon Islands | 1.6 | 1.7 | 1.7 |
| 110 | Gambia | 1.5 | 1.6 | 1.6 |
| 111 | Sierra Leone | 1.5 | 1.6 | 1.6 |
| 112 | Seychelles | 1.4 | 1.5 | 1.5 |
| 113 | United Republic of Tanzania | 1.4 | 1.5 | 1.5 |
| 114 | Lao People's Democratic Republic | 1.2 | 1.3 | 1.2 |
| 115 | Mongolia | 1.2 | 1.3 | 1.2 |
| 116 | Republic of Moldova | 1.2 | 1.3 | 1.2 |
| 117 | Nepal | 1.1 | 1.2 | 1.1 |
| 118 | Guyana | 0.9 | 1.0 | 0.9 |
| 119 | Montenegro | 0.9 | 1.0 | 0.9 |

| | | | | |
|---|---|---|---|---|
| 120 | Grenada | 0.8 | 0.9 | 0.8 |
| 121 | Zambia | 0.7 | 0.8 | 0.7 |
| 122 | Djibouti | 0.6 | 0.6 | 0.6 |
| 123 | Antigua and Barbuda | 0.5 | 0.5 | 0.5 |
| 124 | Timor-Leste | 0.5 | 0.5 | 0.5 |
| 125 | Dominica | 0.4 | 0.4 | 0.4 |
| 126 | Saint Kitts and Nevis | 0.4 | 0.4 | 0.4 |
| 127 | Saint Lucia | 0.4 | 0.4 | 0.4 |
| 128 | Saint Vincent and the Grenadines | 0.4 | 0.4 | 0.4 |
| 129 | Bhutan | 0.3 | 0.3 | 0.3 |
| 130 | Marshall Islands | 0.2 | 0.2 | 0.2 |
| 131 | Samoa | 0.2 | 0.2 | 0.2 |
| 132 | Comoros | 0.1 | 0.1 | 0.1 |
| 133 | Eritrea | 0.1 | 0.1 | 0.1 |
| 134 | Micronesia (Federated States of) | 0.1 | 0.1 | 0.1 |
| 135 | Palau | 0.1 | 0.1 | 0.1 |
| 136 | Tuvalu | 0.1 | 0.1 | 0.1 |
| 137 | Vanuatu | 0.1 | 0.1 | 0.1 |
| 138 | Cook Islands | 0.0 | 0.0 | |
| 139 | Ethiopia | 0.0 | 0.0 | |
| 140 | Guinea-Bissau | 0.0 | 0.0 | 0.0 |
| 141 | Kiribati | 0.0 | 0.0 | 0.0 |
| 142 | Nauru | 0.0 | 0.0 | 0.0 |
| 143 | Niue | 0.0 | 0.0 | 0.0 |
| 144 | Tonga | 0.0 | 0.0 | 0.0 |
| 145 | Uganda | 0.0 | 0.0 | 0.0 |
| | TOTAL | 400.5 | 432.5 | 416.5 |
| | | | | |
| 1 | TOTAL | 18602.7 | 20,090.9 | 19346.8 |
| 33 | TOTAL | 12184.0 | 13,158.7 | 12671.4 |
| 25 | TOTAL | 795.1 | 858.7 | 826.9 |
| 86 | TOTAL | 400.5 | 432.5 | 416.5 |

***Table A1-1 Article 5 countries as subdivided in 4 groups***

## A1.2 Decision 60/44 text

Following the description of the agreed criteria by the facilitator of the contact group on HCFCs, the Executive Committee decided:
In determining criteria for funding HCFC phase-out in the consumption sector in Article 5 countries:

**Cut-off date**
(a) Not to consider any projects to convert HCFC-based manufacturing capacity installed after 21 September 2007;

**Second-stage conversion**
(b) To apply the following principles in regard to second-stage conversion projects for the first stage of HCFC phase-out management plan (HPMP) implementation to achieve the 2013 and 2015 HCFC phase-out compliance targets, to be reviewed by the Executive Committee no earlier than the last Meeting in 2013:

(i) Full funding of eligible incremental costs of second-stage conversion projects will be considered in those cases where an Article 5 Party clearly demonstrates in its HPMP that such projects are necessary to comply with the Montreal Protocol HCFC targets up to and including the 35 per cent reduction step by 1 January 2020 and/or are the most cost-effective projects measured in ODP tonnes that the Party concerned can undertake in the manufacturing sector in order to comply with these targets;
(ii) Funding for all other second-stage conversion projects not covered under paragraph (b)(i) above will be limited to funding for installation, trials, and training associated with those projects;

**Starting points for aggregate reductions in HCFC consumption**
(c) To establish the starting points for aggregate reductions in HCFC consumption, for those Article 5 countries that submit projects in advance of their assessed baseline, at the time of submission of either the HCFC investment project or the HPMP, whichever is first submitted for the consideration of the Executive Committee;
(d) To allow Article 5 countries to choose between the most recent reported HCFC consumption under Article 7 of the Montreal Protocol at the time of the submission of the HPMP and/or the investment project, and the average of consumption forecast for 2009 and 2010, in calculating starting points for aggregate reductions in HCFC consumption;
(e) To adjust the agreed starting points for aggregate reductions in HCFC consumption in cases where calculated HCFC baselines based on reported Article 7 data are different from the calculated starting point based on the average consumption forecast for 2009-2010;

**Eligible incremental costs of HCFC phase-out projects**
(f) To apply the following principles in regard to eligible incremental costs of HCFC phase-out projects for the first stage of HPMP implementation to achieve the 2013 and 2015 HCFC phase-out compliance targets, subject to a review in 2013:
(i) When preparing HCFC phase-out projects in the foam, refrigeration and air-conditioning sectors, bilateral and implementing agencies shall use the technical information contained in document UNEP/OzL.Pro/ExCom/55/47 as a guide;

(ii) The current cost-effectiveness threshold values used for CFC phase-out projects in paragraph 32 of the final report of the 16th Meeting of the Executive Committee (document UNEP/OzL.Pro/ExCom/16/20), to be measured in metric kilogrammes, shall be used as guidelines during the development and implementation of the first stage of HPMPs;
(iii) That countries will have the flexibility to allocate the approved funding from incremental operating costs to incremental capital costs and to allocate up to 20 per cent of the approved funding for incremental capital costs to incremental operating costs, as long as the use of the flexibility does not change the intent of the project. Any reallocation should be reported to the Executive Committee;
(iv) Funding of up to a maximum of 25 per cent above the cost effectiveness threshold will be provided for projects when needed for the introduction of low global warming potential (GWP) alternatives;

**HCFC phase-out in the foam sector**
(v) Incremental operating costs for projects in the foam sector will be considered at US$ 1.60/metric kg for HCFC-141b and US$ 1.40/metric kg for HCFC-142b consumption to be phased out at the manufacturing enterprise;
(vi) For group projects linked to systems houses, incremental operating costs will be calculated on the basis of the total HCFC consumption to be phased out for all downstream foam enterprises;
(vii) The Executive Committee will consider, on a case-by-case basis, funding higher levels of incremental operating costs than indicated in paragraph (f)(v) above when required for the introduction of low-GWP water-blown technology;

**HCFC phase-out in the refrigeration and air-conditioning manufacturing sector**
(viii) Incremental operating costs for projects in the air conditioning sub-sector will be considered at US$ 6.30/metric kg of HCFC consumption to be phased out at the manufacturing enterprise;
(ix) Incremental operating costs for projects in the commercial refrigeration sub-sector will be considered at US$ 3.80/metric kg of HCFC consumption to be phased out at the manufacturing enterprise;
(x) Consistent with decision 31/45 of the Executive Committee, incremental operating costs will not be considered for enterprises categorized under the refrigeration equipment assembly, installation and charging sub-sector;

HCFC phase-out in the refrigeration servicing sector
(xi) Article 5 countries that have total HCFC consumption of up to 360 metric tonnes must include in their HPMP, as a minimum:

a. A commitment to meeting, without further requests for funding, at least the freeze in 2013 and the 10 per cent reduction step in 2015, and if the country so decides, the 35 per cent reduction step in 2020. This shall include a commitment by the country to restrict imports of HCFC-based equipment if necessary to achieve compliance with the reduction steps and to support relevant phase-out activities;

b. Mandatory reporting, by the time funding tranches for the HPMP are requested, on the implementation of activities undertaken in the refrigeration servicing sector and in the manufacturing sector when applicable, in the previous year, as well as a

thorough and comprehensive annual work plan for the implementation of the following activities associated with the next tranche;

c. A description of the roles and responsibilities of major stakeholders, as well as the lead implementing agency and the cooperating agencies, where applicable;

(xii) Article 5 countries that have total HCFC consumption of up to 360 metric tonnes will be provided funding consistent with the level of consumption in the refrigeration servicing sector as shown in the table below, on the understanding that project proposals will still need to demonstrate that the funding level is necessary to achieve the 2013 and 2015 phase-out targets, and if the country so decides, the 2020 phase-out targets:

| Consumption (metric tonnes)* | Funding up to 2015 (US$) | Funding up to 2020 (US$) |
|---|---|---|
| >0 <15 | 51,700 | 164,500 |
| 15 <40 | 66,000 | 210,000 |
| 40 <80 | 88,000 | 280,000 |
| 80 <120 | 99,000 | 315,000 |
| 120 <160 | 104,500 | 332,500 |
| 160 <200 | 110,000 | 350,000 |
| 200 <320 | 176,000 | 560,000 |
| 320 <360 | 198,000 | 630,000 |

(*) Level of baseline HCFC consumption in the refrigeration servicing sector

(xiii) Article 5 countries that have total HCFC consumption of up to 360 metric tones and that receive funding consistent with the above table, will have flexibility in utilizing the resources available to address specific needs that might arise during project implementation to facilitate the smoothest possible phase-out of HCFCs;
(xiv) Article 5 countries that have total HCFC consumption of up to 360 metric tonnes, used in both the manufacturing and refrigeration servicing sectors, could submit HCFC phase-out investment projects in accordance with prevailing policies and decisions of the Multilateral Fund, in addition to funding for addressing HCFC consumption in the servicing sector;
(xv) Article 5 countries that have total HCFC consumption above 360 metric tonnes should first address consumption in the manufacturing sector to meet the reduction steps in 2013 and 2015. However, if such countries clearly demonstrate that they require assistance in the refrigeration servicing sector to comply with these targets, funding for these activities, such as training, will be calculated at US$4.50/metric kg, which will be deducted from their starting point for aggregate reductions in HCFC consumption.

**HCFC phase-out in the aerosol, fire extinguisher and solvent sectors**

(xvi) The eligibility of incremental capital and operating costs for HCFC phase-out projects in the aerosol, fire extinguisher and solvent sectors will be considered on a case-by-case basis.

## Annex 2 - Reactions from Parties Received

**The following reactions were received from Non-Article 5 Parties**

**1.**
Coming to your request, we are in principle fine with the elements, which are already in the Decision XXII/3 and we have no additional inputs to provide in general, except one comment and one general consideration.

The comment is referred to "the measures to manage banks of ozone-depleting substances and ozone-depleting substance destruction projects". On this, what might be interesting to consider for further analysis is the possible role of the voluntary carbon market or voluntary scheme for the phasing out of ozone depleting substances. In previous TEAP analysis we do have an assessment on the size of the banks and the related cost needed for the phasing out with three scenario depending on the efforts. A scenario or model on the voluntary market which show the economic leverage that might come out from the use of the banks might be useful for the policy maker. Indeed I think that would be very difficult for the donors countries to consider the destruction of the ODS as incremental cost in the future due the very high cost already assessed by the TEAP. On the contrary, the use of the voluntary resources in a voluntary carbon market would bring private financial resources to such kind of activities (ODS banks and related GHG reduction) and the MP could address the problem with the banks.

I just wanted to point out a general issue related to the financial aspects. At the EU level there is an orientation to keep the deficit and the sovereigns debts under control in view of the financial crisis. As a consequence, there is a due diligence by the Governments in the management of the cost and the target on not to grow with the costs. Several EU countries are adopting the "zero nominal growth" approach. Based on this, I think that might be potentially problematic for some EU donor member states to deal with an upper replenishment level over the next three years (or beyond).

The best scenario, according with the financial problems which might have the donor countries, would be to have the 2012-14 replenishment level in line with the past replenishment. So in this case any donor country would be in the position to promptly pay its contribution on time according with the commitments and the obligation they have at international level.

**2.**
Overall, based on previous task force reports and what the RTF proposes to do, it seems like the RTF is on the right track. We look forward to a useful report.

Should you wish additional guidance, some elements that may be particularly useful in this replenishment include:

- The ExCom has now approved a number of HCFC projects that should help the RTF establish a more realistic range of costs. For example, we approved projects for Egypt, Saudi Arabia and Turkey that were highly cost-effective, and those cost-effectiveness numbers could even improve for some countries because of economies of scale in major producing and consuming countries. How does using those cost-effectiveness impact estimates for the replenishment? It would be useful to include a range of estimates based on a "worst first" approach reflecting the language in XIX/6(11)(a) and using the lower cost-effectiveness estimates based on projects already approved.

- Although a few projects have been approved for more than 10% of baseline, it may be useful to estimate the impact on the replenishment if projects in the remaining countries were funded only to meet those targets agreed in ExCom decisions for Stage I of the HPMPs.

- It would also be useful if the RTF could estimate the replenishments until the end of the HCFC phase-out.

- Finally, given the economic crisis, it would be useful if the RTF could include in its range of scenarios possible decreases in HCFCs and other ODS consumption, as well as deflation.

**3.**
The Replenishment Study is supposed to provide the basis and a starting point for meaningful negotiations both at the technical and the political levels. We have full confidence in the ability of the Task Force to prepare the Replenishment Report for the forthcoming triennium in accordance with the Terms of reference as laid down in decision XXII/3.

In preparing the Report, we would like to raise the following issues and would be grateful if the Task Force could take them into consideration:

(1) A new Report by the German Federal Environment Agency (UBA) projects that by 2050, 80% of f-gas emissions will stem from stationary and mobile cooling and air-conditioning equipment. The Report “How to avoid f-gases: pathways to a phase-out” (published in November 2010) is a revised version of the report “Fluorinated greenhouse gases in products and processes - technological measures for climate protection” published in 2004. It outlines the main applications in which f-gases are used and explains the state of technology as well as available alternatives, including hydrocarbon systems.

The Report concludes that these emissions are for a major part avoidable if climate friendly natural refrigerants were to be used instead. According to the Report, for several years now, manufacturers have been successfully using hydrocarbons in home, laboratory appliances and commercial refrigeration. Practical experience shows that the use of natural refrigerants does not only drastically reduce direct emissions but that thanks to their high energy efficiency and possible use of waste heat in certain systems, also energy use and resulting indirect emissions can be considerably lowered.

We expect the Task Force to take these findings into account when preparing the Report. We would like to see them particularly reflected when discussing replacement technologies and calculating further costs of reductions in HCFC consumption in developing countries. In particular, we would like to see a transparent comparison between the different technical options, based on experiences gained, and taking direct and indirect costs (immediate and mid-term) and economic advantages (e.g. avoided energy costs) fully into account when calculating incremental costs in different sectors.

(2) ExCom Decision 54/39(h) encourages Countries and agencies "to explore potential financial incentives and opportunities for additional resources to maximize the environmental benefits from HPMPs pursuant to paragraph 11(b) of decision XIX/6" of the 19th Meeting of the Parties. Article 10 of the Montreal Protocol mentions that "The mechanism established under paragraph 1 shall include a Multilateral Fund. It may also include other means of multilateral, regional and bilateral co-operation."

Yet, there are a number of barriers in place that limit the possibilities to provide significant additional resources for a climate friendly ODS phase out, including

- limited recognition of the link between ODS phase-out and climate change and the huge growth potential of high GWP alternatives that are phased in under the MP as a consequence of the HCFC phase out

- little experience in determining the eligibility of the ODS phase out activities as part of climate change projects

- no incentives for A2 Countries that are willing to provide additional funds over and above their obligated contributions under the MLF

TEAP estimated earlier that overall a 20% reduction of climate emissions could be achieved under normal funding conditions. It is estimated by including climate funding for conversion projects this could more than double the positive impact of the HCFC phase out.

We would be interested if TEAP' Task Force could validate and update this estimate and illustrate the potential benefit of the above elaborated proposal with respect to the avoidance of phasing in high GWP alternatives.

(3) The Parties to the Montreal Protocol decided to allow Parties to deliver up to 20 per cent of their contributions to the MLF by bilateral agencies in the form of eligible projects and activities. This instrument has proven to be an important and efficient tool to assist Art 5 Parties in fulfilling their obligations. This decision on the acceptance of bilateral projects as a part of the contributions gave Parties the flexibility needed to allocate sufficient money in their national financing systems.

Bearing in mind that Ozone-Projects often also have an energy-efficiency and a climate component, it might be worthwhile considering to raise the percentage of bilateral projects up to 30% to further improve the Parties flexibility to allocate additional money from different sources for phase out projects under the Montreal Protocol and its MLF.

**4.**
You have requested a summary of issues and topics that I think are important for the Task Force to consider in the 2012-2014 MLF Replenishment Report, in particular those that are related to the funding of the 10% reduction in HCFC consumption in developing countries by 2015. Kindly be aware that the summary of issues/topics below also takes into account that the MOP TOR asks the Panel to provide indicative figures for the periods 2015–2017 and 2018-2020 that is to support a stable and sufficient level of funding, on the understanding that those figures will be updated in subsequent replenishment studies.

I would request that the following four elements are illuminated to the best possible effort:

1. Funding for the Implementation of the Montreal Protocol in the upcoming replenishments shall be stable and sufficient to meet all agreed incremental costs to enable Article 5 Parties to comply with the accelerated phase-out schedule both for production and consumption sectors;

2. Quantification of the funding requirement whereby substitutes and alternatives that minimize other impacts on the environment, including on the climate, take into account global-warming potential, energy use and other relevant factors and selected alternative ensures, as a minimum, climate neutrality. This concept takes in to account the phase-outs of ODS production and consumption sectors globally and the benefit to climate, especially with respect to emissions from developing counties.

3. Quantification of agreed incremental cost funding requirement that takes into account that most cost-effective substitutes are introduced (the assumption here being that HFC based alternatives are most cost effective). Once introduced, however, emission reductions from such alternatives (HFC) in developing countries can get funding from climate related market based mechanism (such as CDM). Quantify potential costs and incomes that can accrue from such climate financing. Such costs and incomes should be quantified and take into account, relevantly, the Indicatives List of Categories of incremental costs and necessary replenishment levels.

4. The impact that the international market, ODS control measures and country phase-out activities and subsidies are likely to have on the supply of and demand for ODS and climate impacting gases and alternatives, the corresponding effects on the price of ozone-depleting substances and alternatives and the resulting incremental costs of investment projects during the period under review.

**5.**

In response to the request from the TEAP Task Force on Replenishment (RTF), please find below some key issues that I believe should be considered when estimating the next replenishment of the Multilateral Fund for the Implementation of the Montreal Protocol (MLF). I apologize for the delay in sending you this response.

Given the mandate of paragraph 2(c) of Decision XXII/3, it is expected that almost all of the estimated funding requirement for the triennium 2012-2014 should be associated with meeting the 2013 and 2015 HCFC control measures for consumption and production.

With respect to production, there have been few developments within the Executive Committee (ExCom) of the MLF that could provide the RTF with more specific guidance as to the level funding that could be agreed to for this sector. Therefore, I feel that the approach taken by the Task Force to estimate funding for the production sector in the 2008 replenishment report would still be largely adequate. Although the issue of eligibility of swing plants has been discussed several times within the ExCom's Subgroup on the Production Sector, there are divergent views on whether such plants are eligible for funding, in light of previous commitments made during the CFC phase-out. It is my view that the RTF's treatment of such plants as non-eligible in the 2008 report continues to apply. This means that HCFC production in China is still the only production to be eligible for MLF assistance at this point in time. In allocating the funding to assist China, it should be recalled that the practice of production phase-out projects is to provide funding gradually as annual reductions are met, meaning that a portion of the funding associated with the 2015 10% HCFC reduction step would likely be provided in 2015-2017 triennium.

With respect to HCFC consumption, China now represents over 60% of the HCFC consumption of eligible countries that have yet to receive assistance from the MLF for meeting the 2013 and 2015 targets. As the Task Force is no doubt aware, China has submitted the four key sector plans through which it envisages to meet these targets. Should funding for these sector plans be agreed to at the next ExCom meeting, the size of the next replenishment will obviously be much more simple to estimate. It is worth noting that for two of the sector plans (PU foams and XPS foams), there are very large divergences between the funding requested for China and the funding estimated by the Secretariat to be required.

Should funding for China and other major countries not be agreed to at the next ExCom meeting, there are three factors that I believe will be key in determining the funding needed to assist countries meet the 2013 and 2015 HCFC control measures. These are: (1) the cost-effectiveness of HCFC phase-out projects (mainly investment projects) that will be approved for non-low-volume consuming (LVC) countries; (2) the quantity of HCFCs to be phased out, and (3) the types of HCFCs and sectors that will be addressed for phase-out.

With respect to the first factor, the cost-effectiveness of projects approved at the last meeting of the ExCom likely provide a good indication of the cost-effectiveness that will be achieved for projects in most non-LVC countries. For a few of the smaller non-LVC countries, these cost-effectiveness figures were close to the applicable threshold (according to Decision 60/44), i.e. Morocco: $9.52/kg; Sudan: $9.79/kg. However, for most non-LVC countries, the cost-effectiveness of projects approved was significantly lower than the thresholds, i.e. Bangladesh: $6.24/kg; Egypt: average of $4.8/kg; Nigeria: $5.4/kg (for HPMP Stage I); Philippines: $5.74/kg; Saudi Arabia: $1.21/kg and $3.55/kg, Turkey: $2.78/kg. Given the historical experience of the MLF, the cost-effectiveness of projects in similar sectors in China should be lower than the average cost-effectiveness of such projects in other countries.

In terms of the quantity of HCFCs to be phased out to allow all countries to meet the 2013 and 2015 targets, there continues to be disagreement within the ExCom on whether, or the extent to which, funding could be provided to help countries curb expected growth between the baseline and freeze years; that is to say if funding for more than 10% of baselines could be provided at this stage. Although the ExCom has provided funding for more than 10% of estimated baselines to several non-LVC countries **on a case-by-case basis**, it can not be assumed that this practice will be followed with all countries. This issue causes a significant uncertainty in the size of the funding requirement for the next replenishment, since the requirement could change drastically depending on the tonnage that is to be funded for phased out. However, one

factor that should somewhat lessen this uncertainty is that China itself has limited its tonnage request to 17.7% of its estimated baseline.

With regards to the types HCFCs and sectors that will be funded for phase-out to meet the 2013 and 2015 control measures, it is clear that, based on ExCom decisions and the experience so far, the focus should be HCFC-141b in PU foams. Most non-LVC countries have sufficient consumption of HCFC-141b to meet their initial targets through the phase-out of this particular HCFC.

It should be noted that China's HCFC phase-out strategy, as set out in the draft HPMP submitted at the 62nd Meeting, places a relatively modest emphasis on HCFC-141b in PU foams, with this HCFC and sector contributing only 50% of the HCFC phase-out in ODP tonnes up to 2015. However, during consultations with China at the meeting, several ExCom members expressed the view that according to ExCom decisions, a significantly greater emphasis on HCFC-141b in PU foams should be placed. Indeed, an analysis of China's HCFC consumption distribution suggests that China has sufficient consumption of HCFC-141b in relatively large enterprises to address 70% or more of the ODP tonnage it indicates would need to be phased out between now and 2015.

Having said this, some level of funding for other HCFCs and other sectors should not be ruled out. As there are few experiences to date in approving funding for other HCFC manufacturing sectors (although a couple of major HCFC-142b phase-out projects in the XPS sector were approved at the last meeting), the cost-effectiveness figures for incremental capital costs used by the TEAP in the 2008 replenishment report may still be more or less adequate for the purpose of making funding estimates for a limited quantity of phase-out in these sectors. For incremental operating costs (IOCs), it is of course important to refer to the fixed IOCs agreed to under Decision 60/44, taking into account that the ExCom has applied these IOCs as caps. Lower IOCs than prescribed by Decision 60/44 were approved when data demonstrated that real IOCs, over a one-year period, were in fact lower.

Funding for the refrigeration servicing sector is unlikely to be an important factor in the size of the next replenishment. While all LVC countries, as well as some non-LVC countries with HCFC consumption in the servicing sector only, will receive funding principally to phase out HCFCs in that sector, the total consumption involved is relatively small. Calculation of funding for these countries should be straightforward since Decision 60/44 is quite specific about the levels of funding countries could receive based on their consumption levels. These countries may receive funding to address up to a 35% reduction of HCFCs in the servicing sector, but the funding needs to be allocated up to 2020. In projects approved so far, generally no more than 55-60% of the funding to achieve the 35% reduction has been allocated prior to

2015 and would, therefore, be counted as part of the 2012-2014 requirement. This trend should normally continue.

One last point related to sectoral distribution of the HCFC phase-out is that the previous assumption that about two thirds of HCFC-22 used in the manufacturing of refrigeration and air conditioning products is for air conditioning, while about one third is for commercial refrigeration, is possibly erroneous. According to the sector plans presented by China at the 62nd Meeting, it appears that 95% or more HCFC-22 consumption in the sector is for the manufacture of air conditioning equipment.

In outlining the key factors likely to have an impact on the size of the next replenishment, I have not touched the issue of climate co-benefits, even though Decision 60/44 provides for funding above that prescribed by cost-effectiveness thresholds to encourage the adoption of low-GWP alternatives. Since the majority of funding for projects to meet the 2013 and 2015 targets will likely be associated with the phase-out of HCFC-141b in PU foams in large-volume consuming countries, and in most of these countries experience suggests that low-GWP alternatives can be introduced in this sector at cost below the cost-effectiveness threshold, the issue of funding for climate co-benefits should not significantly impact on the next replenishment.

I hope that the above-mentioned comments and ideas will be useful to the RTF in the preparation of its report. I will be glad to discuss these further with RTF representatives over the telephone or by e-mail should this be of any additional assistance to the Task Force.

**6.**

We think it will be important to take a broad view of the adequacy of alternatives, so that energy use and safety issues are fully considered as well as the direct environmental impacts of refrigerant use. We also think it important, so far as it is possible, to consider the priority to be given to reductions in use of HCFCs for different sectoral uses e.g. to begin to phase out HCFCs for foam blowing where this will deliver the greatest environmental benefits and to also give priority to the biggest enterprises where this delivers the biggest reductions in HCFC consumption.

I agree there is an issue relating to most cost-effective early actions (foams) with a risk that A5 parties may request additional funding for the phase-out in the RAC sector because of continued growth. I do not think however that A2s should be funding unconstrained growth in the RAC sector and should stick to what has been agreed on this issue at successive Excom meetings. Then, if foams remain the most cost-effective early investment, these should have a priority in HPMPs.

A question was asked about the best environmental choice for RAC in the 2012-2015 periods. The RTF know far more about this than I will ever do. However, my answer is that the choice should not be based on GWP of refrigerant in isolation. Expected leakage rates and energy use remain important factors as do safety considerations and conditions under which the equipment will be operated. Excom has been developing some simple assessments of direct/indirect environmental impacts, which have proved helpful in addressing this thorny issue on a case by case basis.

**7.**

I would like to provide the following observations and comments in relation to the issues that will be addressed by Task Force.

- We consider it important that the Task Force is clearly focussed on addressing funding for compliance obligations arising from the provisions of Montreal Protocol and any subsequent decisions. We note that the last report prepared by TEAP opined on the importance of destruction of ozone depleting substances being undertaken, and we consider such reflections on policy issues are not the province of the TEAP, especially in the context of evaluating (on a technical basis) future replenishment levels of Multilateral Fund.
- We note that many of the uncertainties present in 2008 report have now been resolved, and that more certainty has been provided by the Executive Committee in recent decisions, e.g. with respect to the cut-off dates for eligible production, levels of Institutional Strengthening funding, etc. However, we note there are still some uncertainties that the Task Force will need to reflect upon carefully and perhaps derive some scenarios for the information of Parties.
- Some of the uncertainties we have identified ( but there may well be more) include:
  - the level of tonnage to be phased out, however, we do not share the expectation of the Executive Committee (as expressed in its approval of the 2010 business plans of implementing agencies) that unless otherwise agreed, the level of tonnage to be phase-out by 2015 will be no more than 10% of the baselines of countries. In relation to this, we note that of those HPMPs and projects approved to date with investment components, many of them are phasing out less than 15% of their baseline, and some that are phasing out more than 15% are either addressing consumption in only one enterprise, or have a very cost-effective approach.
  - the cost-effectiveness of already HCFC phase-out management plans and projects, which in some cases are below the cost-effectiveness thresholds agreed by the Executive Committee in Decision 60/44. It is our expectation that as the Executive Committee better understands the phase-out situation in Article 5 Parties, that many more HCFC projects

and HPMPs will be approved with cost-effectiveness below the indicated threshold;

- the number of enterprises which have already received funding from the MLF for the CFC phase-out which will be funded to phase-out HCFCs. Decision 60/44 (b) allows consideration of second-stage conversions being funded in some circumstances where is demonstrated that they are necessary to allow a Party to meet its 2025 or 2020 reduction targets, or where such activities are highly cost-effective. It is still too early to speculate on how many such conversions will be approved by the Executive Committee;
- the level and cost phase-out of HCFC production. We note that the technical audits for China were only approved at the 62nd meeting of Executive Committee and that it is unclear at this point the tonnage which will be phased-out or converted to non-emissive uses, and the associated costs of this phase-out or conversion.

Finally, we note that it may not be appropriate to take for granted annual increases of 3% in the budgets of agencies, of the Fund Secretariat or the Compliance Assistance Programme. With the passing of the 2010 reduction target for so many ozone depleting substances, commensurate reductions in, or elimination of, supporting activities for the phase-out of these substances will need to be considered. With so much effort focussed solely on HCFC phase-out activities now, there is also the possibility of economies of scale being realised, or for consolidation of some activities in the near future (such as rationalisation of project management offices and institutional strengthening activities).

We hope these observations are useful to the Task Force in its deliberations, and we look forward to reviewing the report when available.

**The following reaction was received from an Article 5 Party**

1. The next replenishments should consider the increase for the amount that is devoted to African countries (VLVC's) projects because the HPMP projects already approved for VLVCs until 2020 cannot curve the trend of HCFC consumption notably in Africa countries.
2. The replenishment should consider the increase of the institutional strengthening project amount.
3. The replenishment should consider the HFC control measures since my country support the amendment proposed by USA, Canada, and Mexico.
4. The replenishment should consider a special window for the VLVCs with indicated amounts since they can contest with LVCs like India, China, Brazil etc.

## Reactions from Implementing Agencies received

All four Implementing Agencies were consulted, in some cases this was done via discussions, in other cases reactions were transferred which were taken in due consideration by the Task Force in drafting the report.