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EXECUTIVE COMMITTEE OF
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REVISED ANALYSIS OF RELEVANT COST CONSIDERATIONS SURROUNDING THE FINANCING OF HCFC PHASE-OUT (DECISIONS 53/37(I) AND 54/40)

EXECUTIVE SUMMARY

Overview of HCFCs and HCFC funding issues

1. As of April 2008, the Multilateral Fund has approved projects and activities, which when fully implemented are expected to phase-out some 250,000 ODP tonnes of consumption of ODSs. While, in comparison to this, the 25,765 ODP tonnes of Article 5 HCFC consumption appears modest, this ODP consumption translates into almost 363,400 metric tonnes, making the HCFC phase-out to be addressed seem larger than that achieved by the Fund to date.

2. Currently, three chemicals, HCFC-141b, HCFC-142b and HCFC-22 account for more than 99 per cent of the total consumption of all HCFCs in Article 5 countries. These HCFCs are used mainly in the manufacturing of foam products and refrigeration equipment and in the refrigeration servicing sub-sector. The remaining consumption of HCFCs is used in specialized applications in the aerosol, fire extinguisher and solvent sectors. While there is not yet sufficient data to ascertain precise numbers, it is clear that about 90 countries consume only HCFC 22 for servicing existing refrigeration and air conditioning equipment, while 50 or so Article 5 countries have, in addition, enterprises that use HCFCs in manufacturing. Therefore, the refrigeration servicing sector will play an important role in complying with the 2013 freeze and 2015 reduction, particularly in those 90 or more countries without HCFC-based manufacturing enterprises. Given the experience of the Fund to date, it is likely that those countries that use HCFCs solely for servicing will be able to effectuate a phase-out through the use of an HPMP and related activities such as technician training, recovery and recycling, and conversion incentive programmes, while those countries which use HCFCs in the manufacturing sector will have to augment HPMP activities with sectoral or national investment components.

Existing policies for phasing out HCFCs

3. In line with decision 53/37(i), viable substitute technologies for phasing out HCFCs have been identified in the foam and refrigeration sectors, and their corresponding indicative ranges of costs have been estimated. Specifically, the incremental capital cost (ICC) of converting manufacturing firms to alternatives, and the incremental operational costs (IOC) associated with funding the new alternative have been estimated. That said, the cost ranges currently available do not at this stage provide a basis for recommending project conversion templates or establishing funding thresholds for certain types of conversions, but rather demonstrate the relative levels of capital costs and operational costs associated with conversions so as to better inform the on-going discussion of the Executive Committee. On the basis of this understanding, the Fund Secretariat believes there is an adequate basis for the preparation, review, consideration and approval of initial stand-alone HCFC conversion projects in line with decision 54/39 (d)[1]. However, in regard to sectoral or national HCFC phase-out plans, the Secretariat is not confident that it has the ability to provide informed recommendations to the Executive Committee on the appropriate cost of such plans. Instead, the Secretariat believes that it may be necessary to first develop a cost framework for HCFC phase-out projects on the basis of experience gained

[1] For countries that chose to implement investment projects in advance of completion of the HPMP: (i) the approval of each project should result in a phase-out of HCFCs to count against the consumption identified in the HPMP and no such projects could be approved after 2010 unless they were part of the HPMP; and (ii) if the individual project approach was used, the submission of the first project should provide an indication of how the demonstration projects related to the HPMP and an indication of when the HPMP would be submitted.

through review of a limited number of stand-alone HCFC conversion projects as well as HCFC phase-out management plan (HPMPs) to be prepared by Article 5 countries[2].

4. As noted above, funding of Multilateral Fund projects has been based on the assessment of eligible ICC and IOC. The ICC has been determined on the basis of the cost of equipment necessary to effectuate the conversion. In contrast, the IOC, which, in concept, has paid for the difference between the cost of the use of, for example, CFCs and the HFCs that have replaced them, has been paid for a duration determined by the Executive Committee. That duration has varied between sectors, and has ranged between 0 to 4 years. In some cases, such as in the aerosol sector, where the cost of the alternative is lower than that of the chemical it is replacing, the lower IOC has resulted in a reduction of the funds available to cover the capital cost of the conversion, making conversions more difficult. As it relates to HCFCs, at the present time and with the current stage of commercialisation of new technologies in Article 5 countries, there is a high degree of uncertainty regarding the precise quantification of the cost parameters that comprise IOC in HCFC phase-out projects. However, if the current policies and criteria for funding ODS phase-out remain unchanged, the IOC in HCFC phase-out projects could, depending on the alternative selected take a larger share of total project costs than was typical for similar CFC phase-out projects. The IOC, which are paid in cash, have provided an incentive to firms to undertake early conversion during the CFC phase-out. However, and given the higher cost of alternatives such as HFC-245fa, and the lower cost of zero global warming potential (GWP[3]) alternatives such as hydrocarbons, it appears that the current IOC system could result in a perverse incentive for firms to request conversion to higher priced but higher GWP alternatives, a result that would not appear consistent with the spirit or terms of decision XIX/6 of the Meeting of the Parties. Accordingly, this issue is ripe for in depth consideration by the Executive Committee, and it might be appropriate for some initial stand alone projects to be submitted with the relevant information needed to assess the IOC, which would enable the Committee to consider the issue on the basis of more accurate data.

5. Pending determination of the eligibility of funding for replacement of HCFC-based equipment that had been installed with assistance from the Multilateral Fund (second conversions) it would not be possible for stand alone projects for HCFC phase-out in enterprises that employed such equipment to be submitted. Resolution by the Executive Committee by its 57th Meeting in early 2009 of issues concerning second conversions and installation cut-off date for equipment to be funded for replacing HCFCs would be essential to permit consideration of stand-alone conversion projects to proceed without significant delay.

Foam sector technologies and costs

6. As noted above, approximately 50 Article 5 countries use HCFCs for manufacturing. In that context, the largest use area is the use of HCFC-141b in the production of foams. Luckily, there are a wide variety of alternatives available to replace the use of HCFCs in the foam sector. In this sector, water-based chemicals and hydrocarbon blowing agents have already been proven and are widely applied in Article 5 countries as non-HCFC alternatives to CFCs and will

[2] Funding for the preparation of HPMPs in more than 115 Article 5 countries has been submitted for consideration by the Executive Committee at its 55th Meeting.

[3] GWP is a measure of how much a given mass of greenhouse gas is estimated to contribute to global warming. It is a relative scale which compares the gas in question to that of the same mass of carbon dioxide whose GWP is by definition equal to 1.

continue to be also applied as alternatives to the use of HCFC-141b. The safety requirements associated with hydrocarbons provide operational challenges for very small enterprises; however similar challenges have been overcome for hydrocarbon technology in the aerosol sector. Newer HFC-based technologies are also available and in regular use in non-Article 5 countries. These, however, are yet to be introduced commercially in Article 5 countries. The HFC options have a higher GWP than the HCFCs they replace. Another option, methyl formate technology, has a low GWP, and may meet the needs of Article 5 country enterprises in the production of integral skin foam sub-sector and in some applications in the rigid foam sub-sector, and at lower costs. However, methyl formate cannot yet be considered a mature technology for some applications. The alternatives just described represent all the technology choices that will be available to Article 5 Parties to address the 2013 and 2015 control targets.

7. The document provides a preliminary estimate of the ICC and IOC of conversion from the use of HCFCs in foam enterprises. The magnitude of ICC in the foam sector will be dependent mainly on the choice of technology. On the positive side, ICC will be modest for enterprises that installed new equipment to convert from CFC-11 to HCFC-141b, either on their own or with Multilateral Fund resources. Similarly, water-based technology can, in general, be implemented using HCFC-based process equipment. Related costs needed by these enterprises to effectuate the conversion from HCFCs would mainly consist of technical assistance for training and the trial of new chemical formulations. It is thought that related costs would need to be set at a higher level of funding than in the transition from CFCs to HCFCs. Costs related to conversion of HCFC–based enterprises to hydrocarbon technology relate to the provision of new processing and safety equipment at a similar cost to the equipment supplied for the hydrocarbon technologies used for CFC phase-out. However, as in the CFC phase-out, the capability of small enterprises to absorb the hydrocarbon-based technology is likely to be limited.

8. Although the ICC for conversion in the foam sector appear modest, the IOC will be significant, in particular, for HFC-based solutions, mainly due to the higher cost of the replacement chemicals. If IOC were paid for similar transitional periods to those that had been used in the foam sector for conversion from CFCs, the total funding level for future projects using HFC technologies would be dominated by these costs, that is, the cost paid for operational cost would be much higher than the capital cost of converting the firm to enable the use of HFCs. For hydrocarbon technology, while the precise levels of IOC cannot be fully quantified prior to the review and evaluation of actual projects, the application of current rules and policies would be expected to yield some savings. However, information from one Article 5 country indicates that in some production circumstances, conversions to HCs could be associated with some operational costs.

9. While the above discussion has focused on a more project specific view, experience with CFC phase-out in the foam sector has demonstrated the important role played by the chemicals suppliers and systems houses[4] in tailoring the chemical systems[5] used to manufacture foam to meet the needs of local markets and conditions (climatic and otherwise). These intermediaries, which are well known to many foam manufacturers, are capable of formulating foams systems to

[4] Systems houses are chemical companies that are engaged in the business of bulk pre-blending of foam systems for distribution and sale to foam manufacturers. The pre-blending obviates the need for investment in expensive in-house premixing stations and bulk purchase of several chemical components that are blended in the system.
[5] Foam chemical systems are mixtures of chemical ingredients specially formulated and blended to meet specific foam processing conditions and product quality.

meet the specific needs of end users. In that light, it is believed that commercialisation and penetration in Article 5 countries of both HFC and low-GWP technologies (i.e., hydrocarbons, methyl formate), would be assisted through the forward funding and implementation of projects that target the optimization and validation for Article 5 conditions of foam chemical systems to minimise production costs. Such projects would be directed towards supporting the work of systems houses to facilitate the supply of new, non-HCFC chemical systems to foam producing enterprises.

Refrigeration sector technologies and costs

10. Use of HCFCs in the refrigeration sector is dominated by the use of HCFC 22. In the refrigeration sector the situation regarding replacement of HCFC-22 used in manufacturing has some similarities to the foam sector. Both HFC and hydrocarbon replacements are available to Article 5 countries. While in broad terms each technology has already been used in Multilateral Fund projects, the specific applications and sub-sectors differed significantly.

11. In this context, the possible adoption of low GWP technologies in Article 5 countries, in particular in the refrigeration and air conditioning sub-sectors, is of high priority. The Executive Committee might wish to consider whether to call for some demonstration projects in this sector. This would aim at demonstrating the specific steps and evaluating specific costs associated with the conversion to low GWP technologies.

12. Most HFC alternatives currently available for use in the refrigeration sector have a higher direct GWP than the HCFCs they would replace. On the other hand, the use of low GWP substances, in particular hydrocarbons, involves safety issues. Safety can be readily addressed but results in incremental capital costs similar to those arising in the foam sector, with the added challenge of ensuring safety in servicing activities. HFC and HC technologies represent all the technology choices that are likely to be available to enable Article 5 Parties to address the 2013 and 2015 control targets. It remains unclear if, when, and for what applications low GWP refrigerants with no flammability and low toxicity will become available at a later time. The document provides a preliminary estimate for incremental capital costs and incremental operational costs for the conversion of enterprises using HCFCs in refrigeration manufacturing.

13. With regard to the refrigeration servicing sub-sector, noting the limited information currently available about HCFC use in many Article 5 countries, preliminary estimates of phase-out costs to meet the 2013 and 2015 control measures have been based on Multilateral Fund experience with the range of individual activities funded to achieve CFC phase-out in refrigeration servicing.

14. It is likely that HCFC-22 is used by the service sector of essentially every Article 5 country and that a large number of Article 5 countries will have HCFC consumption almost exclusively in the service sector. In contrast to the situation for CFC phase-out, when in many countries at least some manufacturing was CFC based and could be addressed to support the country in fulfilling its phase-out obligations, in the case of HCFCs there might be no such option for the majority of Article 5 countries. CFC phase-out under the Multilateral Fund has mainly relied on supply restrictions through licensing and quota systems, while at the same time enabling the service sector to cope with dwindling CFC supplies through provision of funding for training in good practices and the provision of tools and equipment. The new challenge for

HCFC phase-out is that supply side management has to start much earlier in the phase-out schedule, and to continue over a longer time-frame.

15. In examining the servicing sector the Secretariat notes that the current and future demand for HCFC-22 for servicing is proportional to the size of the installed base of HCFC-22 air-conditioning equipment in the consuming country. The amount of installed equipment is being constantly enlarged through imports of HCFC-22-based refrigeration equipment. Accordingly, in order to expedite the achievement of future reductions of consumption in the refrigeration servicing sector of Article 5 countries, and to provide a stronger incentive for air conditioner manufacturers to convert from the use of HCFCs, the possibility of introducing early national control schedules on imports of HCFC-22 equipment might be considered. This might influence the demand for Multilateral Fund conversions of HCFC-22 air conditioner manufacturing facilities.

Environmental issues

16. Consistent with decision XIX/6, the Secretariat has examined options on how the Executive Committee could give priority to cost-effective projects and programmes for HCFC phase-out, which minimise other impacts on the environment, particularly with respect to climate, including both GWP and energy use. As a starting point, the Secretariat has explored three basic methodologies, namely, a methodology based solely on GWP; a methodology based in Life Cycle Climate Performance (LCCP) and a methodology based on a ‘functional unit’ approach to life cycle evaluation.

17. In its initial review, the Secretariat did not consider that a methodology based solely on GWP would wholly address the mandate of decision XIX/6, since it would be unable to account for ‘energy use’ as required within the decision. The development of a formal LCCP is data-intensive and requires the input of a substantial number of variables, not all of which might be known, either to the enterprise or a country, at the time of the funding application. With the GWP and LCCP approaches representing the two extremes of the spectrum, the Secretariat has been assessing intermediate options which might overcome the disadvantages of each. This has resulted in the initial evaluation of a ‘functional unit’[6] approach which offers the robustness of a simplified and less data-intensive methodology, while ensuring that the key criteria outlined in decision XIX/6 can be taken into account. The primary output of this methodology would be a comparative assessment of lifecycle climate impacts taking into consideration the GWP of the substitute, the amount of substance used, the energy consumed in operation, and the emission functions through the life-cycle.

18. This approach needs further development and evaluation across a wider range of sectors to provide assurance that the basic methodology can be applied more widely. With this in mind, the Secretariat is seeking the views of the Executive Committee as to whether it wishes the Secretariat to continue further developing this methodology in order to report in a more detailed fashion at a subsequent Executive Committee meeting.

[6] The ‘functional unit’ approach focuses on a typical use of the substance in a sector, called ‘element’, in order to characterise the impacts related to that ‘element’ throughout its lifecycle. The purpose is not to calculate the precise climate impact for each and every application, but to characterise these impacts so they can be used for comparing technologies.

Co-financing

19. The Multilateral Fund experience to date, principally in the chiller sector, suggests that significant time is needed to prepare, approve and implement projects co-funded by different entities. Given the time based reduction commitments of the Montreal Protocol, it is difficult for countries to risk having their projects delayed for the uncertain prospect of co- funding. Accordingly, if the slow rate of support by other funding entities were to continue, it would call into question the possibility of using other institutions to support Multilateral Fund activities. In order to reduce this obstacle, it would be possible for the Fund Secretariat to approach other institutions to see if clear methodologies and more streamlined mechanisms can be developed to enable the other institutions to top up Multilateral Fund ozone funding in order to achieve additional climate benefits. Exchange with other institutions could commence once discussion in the Executive Committee has progressed regarding certain issues raised in this document, in particular relating to cut-off date, second conversion and how to minimise other impacts on the environment.

20. In any event, through the preparation of HPMPs, countries and bilateral and implementing agencies have been encouraged to explore potential financial incentives and opportunities for additional resources to maximize the environmental benefits pursuant to paragraph 11(b) of decision XIX/6. Accordingly, the objectives of co-financing and a preliminary framework for such projects as might be applied to HCFC projects that could facilitate cooperation with possible co-financing entities, could be considered at a future meeting. It would be important for a preliminary framework to encompass guidance for projects where the additional benefits created through support by the Fund might, either now or in the future have a certain value, for example by being eligible for carbon financing.

I. INTRODUCTION

1. This preliminary discussion document that contains an analysis on several relevant cost considerations surrounding the financing of HCFC phase-out is presented in response to the Executive Committee's decision 53/37(i).

I.1 Executive Committee's mandate

2. At its 53rd Meeting in November 2007, the Executive Committee considered a paper prepared by the Fund Secretariat on options for assessing and defining eligible incremental costs for HCFC consumption and production phase-out activities.[7]

3. The Executive Committee concluded by requesting, *inter alia*, "that the Secretariat, in consultation with technical experts with knowledge of experiences in Article 5 countries with different levels of development and non-Article 5 countries, would prepare by 25 March 2008 a preliminary discussion document providing analysis on all relevant cost considerations surrounding the financing of HCFC phase-out, taking into account the views expressed by Executive Committee Members in the submissions referred to in paragraph (l), and including:

(a) Information on the cost benchmarks/ranges and applicability of HCFC substitute technologies; and

(b) Consideration of substitute technologies, financial incentives and opportunities for co-financing which could be relevant for ensuring that the HCFC phase-out resulted in benefits in accordance with paragraph 11(b) of decision XIX/6 of the Nineteenth Meeting of the Parties" (decision 53/37(i)).[8]

4. The Secretariat introduced the paper requested under decision 53/37(i) to the Executive Committee at its 54th Meeting. In the ensuing discussion, several issues were raised by the Committee, inter alia, the need to act immediately on HCFC phase-out, and to ensure that it would result in benefits in accordance with paragraph 11(b) of decision XIX/6; the calculation of IOC as a major component of the overall cost of phase-out projects; the cut-off date for newly established manufacturing enterprises; and the eligibility of second conversions. Mention was also made of the need to minimize the environmental impact of HCFC phase-out activities and to consider using other environmental indicators in addition to ODP, to take account of the cost implications of phase-out for LVC countries, and to ensure that HCFC phase out was integrated as much as possible with CFC phase-out. Several views were expressed in regard to co-financing issues, namely, that seeking co-financing possibilities probably should be an option; the need to gather information concerning sources of funding that were additional to the Global Environment Facility (GEF), whose timelines were considered by some to be too long; that co-financing should bring additionality, and that the main source of funding should remain the Fund itself.

5. After hearing a statement from the facilitator of the contact group that was established by the Executive Committee to consider the guidelines for the preparation of HPMPs and relevant cost considerations surrounding the financing of HCFC phase-out, the Committee decided to

[7] UNEP/OzL.Pro/ExCom/53/60.

[8] Executive Committee Members were invited to submit their views on elements to be considered in the guidelines for the preparation of HCFC phase-out management plans, cost considerations to be taken into account by the Secretariat, cut-off date for funding eligibility, and second-stage conversions to the Secretariat by 15 January 2008.

consider at its 55th Meeting a revised version of document UNEP/OzL.Pro/ExCom/54/54 which would take into account any comments that Members had submitted to the Fund Secretariat by the end of April 2008 (decision 54/40).

I.2 Scope of the paper

6. Decision 53/37(i) provides that the existing policies and guidelines of the Multilateral Fund would be applicable to the funding of HCFC phase-out unless otherwise decided. Accordingly, the following underlying principles were used for the analysis:

(a) Assumptions in this paper regarding the extension of existing policies are without prejudice to any future policy discussion of the Executive Committee on funding guidelines;

(b) Analysis of eligibility issues, such as the question of whether to fund a second conversion (i.e., replacement of HCFC-based equipment that had been installed with assistance from the Multilateral Fund) or funding of manufacturing capacity established after a certain cut-off date, is not considered part of the mandate of this paper. Based on decision at the 54th Meeting (decision 54/5 (iii)) funding for preparation of HCFC phase-out projects could not be considered for approval until the 56th Meeting and the consequent projects are unlikely to be submitted in advance of the 58th Meeting. Resolution of the policy for establishing a cut-off date for equipment installation by the 57th Meeting in early 2009, should the Executive Committee wish to do so, would permit stand-alone phase-out projects to be considered with little if any delay; and

(c) Preparation of this paper has been undertaken without prejudice to decision XIX/10 of the Meeting of the Parties regarding terms of reference for the study on the 2009–2011 replenishment of the Multilateral Fund for the Implementation of the Montreal Protocol and without prejudice to the preparation of that study.

7. The paper covers the following main content:

(a) A summary of policies for funding HCFC phase-out, and an overview of HCFCs uses in Article 5 countries. This is supported by Annex I, Relevant policies and decisions adopted by the Parties to the Montreal Protocol and the Executive Committee regarding phase-out of HCFCs, and Annex II, Overview of HCFC consumption in Article 5 countries;

(b) An analysis of the incremental costs for phasing out HCFC consumption in the foam sector, supported by Annex III containing a detailed analysis on technical and costs issues related to the foam sector. The cost analysis benefited from the experience gained in the Multilateral Fund after reviewing over 1,000 investment projects for phasing out CFCs used as blowing agents. Representative samples of projects were selected from the Secretariat's inventory of approved projects database[9] for review with a view to identifying the nature, the extent of application and the main characteristics of various alternative technologies to CFC-11 and their applicability to conversions from HCFCs to a final technology. The ICC and IOC of the selected samples of projects were also reviewed against the background of information provided in project completion reports since some of them could be also applied to the phase-out of HCFCs[10]. The prices of equipment and chemicals were examined to determine whether significant differences existed between those at the time of project approval and at the time the project completion report was submitted three to four years later. Price and other relevant project information was extracted from project completion reports submitted between late 1998 and mid 2006. Prices of chemicals were compared with those provided by a selected number of Ozone Units in their progress reports on the implementation of the country programmes as well as by manufacturers of alternative blowing agents. The information obtained from the analysis was used as a starting point for estimating the possible incremental costs for phasing out HCFCs. In order to provide the necessary background information, including prices of conversion technologies which are currently mature in non-Article 5 countries, published information was reviewed and experts with knowledge of these technologies were consulted. The total information obtained provided the basis for estimating indicative incremental capital and operating cost ranges;

(c) An analysis of incremental costs for phasing out HCFC consumption in the refrigeration sector, supported by Annex IV containing a detailed analysis on technical and costs issues related to the refrigeration sector, including the service sector. The cost analysis could not be based on existing experience to the same degree as in the foam sector. While Multilateral Fund experience in conversion of mass production of refrigeration equipment is available, HCFC-based equipment is manufactured for different market segments, and has different sizes and is produced in different quantities than previous projects. In addition, there is no experience with most of the non-ODS refrigerants, which are likely alternatives to HCFC-22. Since existing experience relating to project cost could not be translated directly, the Secretariat used information in the HCFC studies already presented, in particular that on HCFCs in China. The experience in project assessment was transferred to the new sectors, input collected from experts and production equipment manufacturers, and used the approach of defining model companies to define the related conversion cost. A different analysis is presented for the service sub-sector, which is based on the extensive Multilateral Fund experience that started in 1991. Special consideration has been given to refrigerant management plans (RMPs) approved under decision 31/48 and to terminal phase-out management plans (TPMPs) approved under decision 45/54;

(d) Environmental issues, in particular the necessary steps to operationalize

[9] The inventory of approved projects is the Secretariat's main database on projects funded under the Multilateral Fund, providing records of all projects approved by the Executive Committee, including, among many others, the conditions of approval, conversion technology, incremental capital and operating costs, completion date.

[10] Project completion reports submitted by implementing agencies provide records of implementation of all approved projects, including information on actual expenditure of the approved incremental capital costs and actual prices of the blowing agents used before and after conversion of the projects, actual technology used, and lessons learned from the use of the technology.

decision XIX/6 in the Multilateral Fund context, supported by Annex V;

(e) Incentives and opportunities for co-financing; and

(f) Recommendations.

8. In preparing this paper, consideration was given to the input received from Executive Committee Members as requested by decisions 53/37(l) and 54/40. In regard to decision 54/40, comments were received from the Governments of China, the Dominican Republic, Germany and Lebanon and from UNDP. A number of the comments relate to detailed incremental cost issues. These will be relevant to the consideration of stand alone projects in due course, in particular during the Secretariat's project review process. Comments also relate to policy issues such as the treatment of IOC for HCFC conversion projects, resolution of which has not been specifically proposed in this paper. Other comments have been taken into account in the preparation of the paper as appropriate. The comments are reproduced in full in Annex VI to the present paper.

I.3 Policies for funding HCFC phase-out

9. The evaluation of the incremental costs of Multilateral Fund projects is based on the general principles agreed by the Parties to the Montreal Protocol at their 2nd Meeting.[11] On the basis of these principles, and on the Indicative List of Categories of Incremental Costs, the Executive Committee has developed specific policies and guidelines for categories of incremental costs in different industrial applications. In the principal sectors of foam and refrigeration, policies have been tailored to projects for CFC phase-out. Projects for the phase out of HCFCs have similarities, but some important differences that require reconsideration and possible amendment of existing rules.

10. Funding of Multilateral Fund projects has been based on the assessment of eligible ICC and IOC. ICC are related to the additional equipment that would be needed to replace ozone depleting substances (ODS) with the alternative technology selected by the enterprise, technology transfer, training, trials and commissioning. IOC reflect changes in costs attributable to the conversion to ODS alternatives and arise from changes in chemicals used in the manufacturing process such as propellants, refrigerants or foam blowing agents. The level of IOC is influenced by fluctuations in prices of raw materials and the period of time over which such costs are paid. As decided by the Executive Committee, the duration of IOC in Multilateral Fund projects has varied among industrial sectors from zero (no IOC) for enterprises manufacturing compressors or MAC systems to four years for aerosol and flexible slabstock manufacturing enterprises (see Annex I).[12]

11. As the number of phase-out projects increased, capital costs became well known and generally decreased over time. The input data for calculation of IOC always contained uncertainties that frequently did not lend themselves to prior verification. However the very large number of projects reviewed in the principal sectors enabled the emergence of broad norms with

[11] Appendix 1 of decision II/8 (Financial Mechanism).
[12] The duration of IOC for the sectors where HCFC technologies have been chosen to phase-out the use of CFCs in Article 5 countries is presented in Annex I to this document.

which requested IOC could be compared. Costs for sector and national phase-out plans were subsequently reviewed with the benefit of this experience.

12. At the present time and with the current stage of commercialisation of new technologies in Article 5 countries, there is a high degree of uncertainty regarding the precise quantification of the cost parameters that comprise IOC in HCFC phase-out projects. For example the quantities and proportions of chemicals in new foam formulations and the prices and availability of these in Article 5 countries, particularly HFCs. However, if the current policies and criteria for funding ODS phase-out remain unchanged, IOC in HCFC phase-out projects in both the foam and refrigeration sectors would take a larger share of total project costs than was typical for similar CFC phase-out projects. IOC, being the only support actually paid in cash, have provided an incentive to enterprises during the CFC phase-out. However the maximum financial incentive is obtained by selecting the least economically sustainable technology option, that is, the option with the highest IOC. The analysis undertaken in this document attempts to show the implications of these cost components on Multilateral Fund funding obligations. However, it would be difficult to provide appropriate technical guidance to the Executive Committee on the costs of sectoral or national phase-out plans related to the conversion of manufacturing capacity without project-by-project cost assessment experience.

13. Special funding options have been agreed by the Executive Committee for funding projects from low-volume consuming (LVC)[13] countries with manufacturing facilities by establishing a special funding window for investment projects where the cost-effectiveness threshold values[14] would not apply. However, for the phase-out of HCFCs, Article 5 countries have been categorized in two groups, namely countries with HCFC consumption in the refrigeration servicing sector and countries with HCFC consumption in both the manufacturing and refrigeration servicing sectors[15]. For the phase-out of ODS by small and medium-sized enterprises (SMEs) the guidelines provided for a funding window to facilitate conversions of significant groups of small enterprises in the aerosol and foam sectors from non-LVC countries. Whether or not the Executive Committee may wish to continue with a similar practice in the case of HCFCs is an issue for further consideration by the Executive Committee.

14. As HCFCs[16] are controlled substances under the Montreal Protocol, specific decisions addressing the phase-out of these ODS have been taken by the Parties since their 5th Meeting in November 1993, and by the Executive Committee since its 12th Meeting in March 1994. Of particular importance to the phase-out of HCFCs are those decisions of the Executive Committee that request implementing agencies to provide a full explanation of the reasons why conversion to HCFC-based technology was recommended, including analysis of prospective non-HCFC alternatives. Furthermore, it had to be made clear that the enterprises concerned had agreed to

[13] A LVC country is a country with a CFC baseline consumption of 360 ODP tonnes. As of March 2008, there are 102 Article 5 countries classified as LVC countries.

[14] Cost-effectiveness threshold values applicable to different industrial sectors were adopted by the Executive Committee at its 16th Meeting as a way to prioritize approval of investment projects. The cost-effectiveness value is calculated as the ratio between the sum of the total incremental capital and operating costs and the total amount of ODS to be phased out in ODP kilograms. Additional information on cost-effectiveness and the threshold values adopted by the Executive Committee are presented in Annex I to this document.

[15] The guidelines for the elaboration HPMP as agreed by the Executive Committee at its 54th Meeting are based on this classification of Article 5 countries.

[16] All HCFC decisions adopted by the Parties to the Montreal Protocol and the Executive Committee are presented in chronological order in Annex I to the present document.

bear the cost of subsequent conversion to non-HCFC technologies. Information on alternative technologies provided by implementing agencies over the years as a result of these decisions by the Executive Committee has also informed the review of prospective technologies considered in this document.

15. At its 53rd Meeting the Executive Committee considered the policy framework for funding the phase-out of HCFCs, and decided that the existing policies and guidelines of the Fund would be applicable to funding HCFC phase-out unless otherwise decided in light of, in particular, decision XIX/6 (paragraph d of decision 53/37). Pending determination of the eligibility of funding second conversion projects, it would not be possible for stand alone projects for HCFC phase-out in enterprises that had received Multilateral Fund funding for conversion to HCFCs to be submitted. However with a minimum of 65 percent of current HCFC consumption in the foam sector estimated to be associated with enterprises that have not so far been supported by the Multilateral Fund, there is scope for stand-alone projects to be prepared and submitted prior to reconsideration of policies related to second conversions.

16. Subsequently, at its 54th Meeting, the Committee adopted guidelines for countries to develop a staged approach to the implementation of their HPMP through developing over-arching plans to achieve total phase-out of HCFCs. Depending on the availability of resources, countries should employ these guidelines to develop, in detail, stage one of the HPMPs, which would address how countries would meet the freeze in 2013 and the 10 per cent reduction in 2015, with an estimate of related cost considerations. Accordingly, countries with HCFC use only for servicing refrigeration systems would be required to develop an HPMP with activities similar to those being required for RMPs and TPMPs, while countries with HCFC-based manufacturing enterprises would develop activities in the context of national or sector performance- based plans. The guidelines also allow countries that choose to implement investment projects in advance of completion of the HPMP to do so, provided that the approval of each project results in a phase-out of HCFCs that counts against the consumption identified in the HPMP as a starting point for aggregate reductions, and that no such projects could be approved after 2010 unless they were part of the HPMP. If the individual project approach was used, the submission of the first project should provide an indication of how the demonstration projects related to the HPMP and an indication of when the HPMP would be submitted (decision 54/39)[17].

17. This discussion paper has therefore also been prepared against the background of the policies and guidelines related to HCFCs as outlined above and in Annex I of the document.

I.4 Overview of HCFC uses

18. The total consumption of HCFCs of 363,372 metric tonnes in all Article 5 countries in 2006 is more than two times the CFC consumption of 178,144 metric tonnes reported in 1995 when the maximum amount ever of CFCs was reported. However, the overall negative effect of HCFCs on the ozone layer (i.e., 25,765 ODP tonnes in total) is lower than that of CFCs (176,405 ODP tonnes) due to their lower ozone depleting potential[18].

[17] The full text of decision 54/39 is presented in Annex I to the present paper.
[18] These figures do not include consumption of ODS by the Republic of Korea, Singapore and United Arab Emirates (i.e., Article 5 countries that have not received assistance from the Multilateral Fund).

19. The 2006 HCFC consumption in Article 5 countries can be characterized as follows:

(a) Consumption of HCFC-141b, HCFC-142b and HCFC-22[19] represented more than 99 per cent of total HCFC consumption. Small levels of HCF-123 and HCFC-133 (0.6 per cent) have been reported in very few countries;

(b) HCFC consumption in 71 countries was below 360 metric tonnes. Twenty nine other countries[20] either reported zero consumption or did not report any consumption;

(c) HCFC-141b was used in 40 Article 5 countries[21], 20 of which had a consumption below 10 ODP tonnes (91 metric tonnes), while HCFC-142b was used only in 19[22] Article 5 countries, 18 of which had a consumption below 10 ODP tonnes (154 metric tonnes);

(d) Seventy[23] of the 117 Article 5 countries that reported consumption of HCFC-22[24] had consumption below 10 ODP tonnes (182 metric tonnes); and

(e) HCFCs were mainly used in the manufacturing of foam products (32.5 per cent of the total HCFC consumption), and in the refrigeration manufacturing and servicing sub-sectors (66.2 per cent). Small amounts were also used in the aerosol (0.2 per cent), fire extinguisher (0.1 per cent) and solvent (1.0 per cent) sectors.[25]

20. These data indicate that there are a few countries with a high level of HCFC consumption and the presence of a large number of SMEs among Article 5 countries. These conclusions are supported by the fact that, based on the analysis of funded individual foam projects, more than 80 per cent of all foam enterprises that converted from CFCs to HCFC-based technologies were located in no more than 12 Article 5 countries. In the same manner, it is estimated that more than 70 per cent of all foam enterprises in Article 5 countries had an annual CFC consumption below 40 ODP tonnes per year.

21. Taking into consideration that about 99 per cent of HCFC consumption occurs in the foam and refrigeration sectors, this paper addresses only these two sectors in order to gain experience and achieve early results in reducing HCFC consumption at the national level. However in due course it will be necessary to develop a similar understanding of technology and cost structures in the remaining sectors where HCFCs are consumed.

[19] The ODP values of HCFC-141b is 0.11, of HCFC-142b is 0.065 and of HCFC-22 is 0.055.
[20] Twenty seven of the 29 countries are currently classified as LVC countries.
[21] Excluding 1,028.7 ODP tonnes (9,352 metric tonnes) consumed by Republic of Korea, Singapore and United Arab Emirates.
[22] Excluding 126.7 ODP tonnes (1,949 metric tonnes) consumed by Republic of Korea and Singapore.
[23] Excluding 1,213.9 ODP tonnes (22,071 metric tonnes) consumed by Republic of Korea, Singapore and United Arab Emirates.
[24] An additional 16 Article 5 countries had reported HCFC-22 consumption in 2005.
[25] HCFC surveys conducted by UNDP for 12 selected Article 5 countries (UNEP/OzL.Pro/ExCom/51/Inf. 2).

II. INCREMENTAL COSTS FOR PHASING OUT HCFC CONSUMPTION IN THE FOAM SECTOR

22. Through the assistance of the Multilateral Fund over 89,370 ODP tonnes of CFCs used as foam blowing agent have been phased out in Article 5 countries. These include CFC-11 used in flexible and rigid polyurethane foams and CFC-12 in extruded polyethylene and polystyrene foams sheets and nets. Article 5 countries selected permanent technologies to phase-out CFC-11 used in the rigid and integral skin sub-sectors, including water-based systems, hydrocarbons (pentanes) for enterprises that could safely operate foam producing equipment using flammable substances, as well as HCFCs as a transitional technology. The use of HCFCs as an alternative blowing agent accounted for about 40 per cent of all CFCs phased out. The use of CFC-11 and CFC-12 in the other foam sub-sectors was phased out using permanent conversion technologies[26].

23. In most non-Article 5 countries, foam blowing technologies based on use of HFCs (mainly HFC-245fa, HFC-365mfc and its blend HFC-365mfc/HFC227ea), methyl formate, and other less widely used technologies have been deployed as replacement for HCFCs used initially as transitional CFC phase-out technologies in the same manner as in Article 5 countries. Although their current availability is limited in Article 5 countries due to lack of demand, these technologies could be used in Article 5 countries also for phasing out HCFCs as a blowing agent.

II.1 Range of costs for phasing out HCFCs

24. Similar to the phase-out of CFCs in foam applications, the incremental capital costs (ICC) for conversion from HCFCs to non-ODS-based technologies depends on the enterprise's existing baseline equipment; the type of foam products being manufactured and the volume of production; the alternative blowing agent selected; and the location of the enterprise, which in several cases could be an important factor for deciding whether or not to select a technology that uses flammable substances.

Ranges of incremental capital costs

25. As requested in decision 53/37(i), two parallel ICC estimates for the cost benchmarks/ranges in relation to HCFC substitute technologies in foam applications were made. One has been based on the retrofit of existing equipment and another on the replacement of existing equipment for the following alternative technologies: water-based systems, hydrocarbons (both pentane and cyclopentane), HFC-245fa and methyl formate. The description below explains the reasons for two parallel estimates.

26. For the conversion from HCFCs to HFC, water-based systems or methyl formate technology:

(a) Based on existing policies, no additional capital costs for replacing existing equipment will be required by all the rigid polyurethane and integral skin foam

[26] CFC-12 used for producing extruded polyethylene and polystyrene foam sheets was phased out mainly with butane and liquid petroleum gas (LPG). CFC-11 in flexible slabstock polyurethane foam sub-sector was phased out using methylene chloride and liquid carbon dioxide while CFC-11 used in moulded polyurethane foam was phased-out using water-based systems.

enterprises that upgraded their production facilities to allow for the interim use of HCFC blowing agents with assistance from the Multilateral Fund, except where such a need is technically justified and fully demonstrated[27]. Costs related to technology transfer, training, trials and commissioning would be required to adapt the alternative technologies to local conditions;

(b) The same conditions as in paragraph (a) above will apply to enterprises that have modified or replaced their CFC-based equipment for use with HCFCs without assistance from the Multilateral Fund, since such enterprises would have similar baseline as those that were assisted by the Multilateral Fund. Similarly the same conditions will apply to enterprises that established new facilities with high pressure dispensers. Assistance for technology transfer, training, trials and commissioning would be required; and

(c) Capital cost for retrofit or replacement of existing baseline equipment as well as technology transfer, training, trials and commissioning, might be required only for those enterprises that still process HCFC-141b foam on hand-mixing facilities and possibly low pressure dispensers either installed after the existing eligible cut-off date of 25 July 1995 or that were not eligible for funding during the Multilateral Fund intervention. The mode of funding will, however, depend on eligibility rules that may be decided by the Executive Committee. Thus, cost benchmarks for the replacement option have been estimated to address such an eventuality.

27. Conversion to pentane-based technologies for rigid or integral skin polyurethane foam enterprises will involve major capital costs compared to other available technologies. These will require high pressure dispensers suitable for use with hydrocarbon blowing agents, new polyol pre-mixers, hydrocarbon storage systems, and safety equipment to handle flammable substances. Local works to accommodate the hydrocarbon storage system and plant modifications would also be needed. In some circumstances plant relocation could be required. However, recent developments in the hydrocarbon technology and equipment design would appear to make the application of the technology more cost-effective for medium scale foam producing enterprises (Appendix 2 of Annex III).

28. Table II.1 below provides a summary of the ICC ranges for various foam applications. These costs are based on enterprises with only one foam dispenser and auxiliary equipment in the baseline, and with HCFC consumption of 5, 25 or 75 metric tonnes (or 0.6, 2.8 or 8.3 ODP tonnes) for manufacturing rigid foams, or 10 or 30 metric tonnes (or 1.1 or 3.3 ODP tonnes) for manufacturing integral skin foams. These levels of consumption represent typical small scale, medium scale and large scale operations. The minimum cost in the range was based on retrofitting all required equipment items, while the maximum cost was based on the cost of replacing old equipment with new equipment, and represent the absolute levels. Costs of technology transfer, training and trials, which are a component of ICC, were estimated at a higher level than for the transition from CFCs to HCFCs due to an anticipated need for more

[27] As a requirement for funding Multilateral Fund projects, enterprises converting to HCFC-based technologies had to make a commitment, together with their Governments, to phase out the residual ODP without further assistance from the Multilateral Fund. Almost all the justifications for the use of HCFC-141b in Multilateral Fund projects confirm that the final conversion would not require additional investment in equipment.

activities and higher amounts of chemicals to optimise foam formulations resulting in potentially higher cost of trials than was the case with transition to HCFC-141b.

29. The calculations show that in all cases except conversion to hydrocarbon technology the retrofit costs are much lower than the replacement option. In the case of conversion to hydrocarbon technology, it was observed that the difference between the cost of a retrofit and that of replacing the existing dispenser is minimal. Incremental capital costs for HFC-365mfc and methyl formate would be similar to those of HFC-245fa, except for possible replacement of storage tanks.

Table II.1: Summary of incremental capital cost ranges for various foam applications (US $)

Foam application	**HFC-245fa/HFC-365mfc/ methyl formate**		**Water-based systems**		**Pentane**	
	Low	**High**	**Low**	**High**	**Low**	**High**
Panels and domestic and commercial refrigeration						
Retrofit	30,000	60,000			375,000	710,000
Replacement	100,000	195,000			385,000	780,000
Pipe in pipe and thermoware (*)						
Retrofit	30,000	60,000	25,000	55,000	375,000	710,000
Replacement	100,000	195,000	95,000	180,000	385,000	780,000
Spray foam (**)						
Retrofit	15,000	55,000	15,000	55,000		
Replacement	50,000	110,000	60,000	110,000		
Discontinuous block (box) foam (***)						
Retrofit	15,000	55,000	15,000	40,000		
Replacement	85,000	140,000	65,000	95,000		
Integral skin foam						
Retrofit	40,000	70,000	75,000	125,000	265,000	405,000

(*) Water-based systems would have limited application in pipe in pipe while pentane would have limited applications in thermoware.
(**) The flammability of pentanes would make their on-site application unacceptable.
(***) Box foam operation would make the use of pentane risky.

Ranges of incremental operating costs

30. The levels of incremental operating costs for conversion from HCFCs to non-ODS-based technologies depend mainly on the nature of the new formulations and the relative prices of chemicals used in those formulations. Costs associated with increase in foam density, where applicable, and in-mould coating chemicals used in water-blown integral skin foams could increase the level of operating costs. For hydrocarbon technologies additional maintenance and energy usage costs due to installation of additional new equipment, and additional insurance cost due to the use of flammable substances, also drive up the IOC.

31. The proportions of main chemical ingredients in foam formulations, namely the blowing agent, the polyol and the isocyanate (or MDI[28]) and their prices are the key determinants of the level of IOC. Prices of these main chemical ingredients have varied widely among Article 5 countries and continue to be so as shown in Table II.2 below. As per the experience with the

[28] MDI: methylene di-phenyl di-isocyanate.

phase-out of CFCs, this situation could result in substantial incremental operating costs for one enterprise but savings for another enterprise for the same type and amount of foam produced, depending on the prices of some or all of the ingredients, and the price differences before and after conversion. The use of relative foam system prices (for HCFC and alternative blowing agent) instead of the prices of individual chemicals where enterprises use premixed systems could help to mitigate some of the discrepancies in chemical prices.

Table II.2: Current prices of chemicals used in foam formulations

Chemical	**Prices US $/kg**	
	Low	**High**
HCFC-141b	2.50	3.80
MDI	3.00	3.50
Pentane	1.90	2.50
Cyclopentane	2.10	3.30
HFC-245fa	10.40	12.00
Methyl formate	2.20	3.20

32. Increase in foam density, which is a cost penalty resulting from the cost of additional foam material, has a significant impact on the IOC, representing 50 per cent or more of the total operating costs in some cases.[29] The levels of increases in foam density used in calculating incremental operating costs were based on the transition from CFC-11 to HCFC-141b, and need to be revisited for the phase-out of HCFC-141b. However, information currently available appears to indicate that foam density increase would not be an issue with the conversion from HCFC to HFC and methyl formate alternatives.

33. Ranges of IOC for the following alternative technologies: water-based systems, hydrocarbons (both pentane and cyclopentane), HFC-245fa and methyl formate were calculated. The calculations were based mainly on the functional proportions of main chemical ingredients in the foam formulations[30], their prices[31] and, where applicable, factors that impact the level of the given IOC. The calculations were checked against approved projects to ensure consistency and accuracy.

[29] The levels of increase in foam density associated with different foam applications were approved at the 31st Meeting of the Executive Committee (decision 31/44) with a view to revisiting the issue in future and making modifications where necessary.

[30] The proportions are based on the functional relationships between the molecular weights of HCFC and the alternative chemical and, where available, any known mitigating factors (e.g. resulting from potential optimization).

[31] The prices of HCFC-141b, pentane and MDI were based on the range of prices reported in project completion reports in the 2000 to 2006 period compared with the latest prices provided in March 2008 by some Article 5 countries through the bilateral and implementing agencies as well as information provided in comments received in response to Decision 54/40. The prices of HFC-245fa and methyl formate were based on prices provided by the manufacturers. The lower price of HFC-245fa is reported global list price for bulk containers (iso-tank) while the higher price is estimated price for small packages, based on a 15 per cent difference.

Table II.3: Summary of annual incremental operating cost ranges for various foam applications per metric kilogram of HCFC-141b phased-out (US $/kg)[32]

Blowing agent	**Rigid foam**		**Integral skin foam**	
	Low	**High**	**Low**	**High**
HFC-245fa	2.20	5.30	0.40	1.14
Methyl formate	(1.40)	(2.20)	1.00	1.66
Water-based systems	1.45	2.00	7.40	12.48
Pentane	(1.25)	(2.20)	(1.84)	(2.84)
Cyclopentane	(1.15)	(1.80)	(0.76)	(1.41)

34. To demonstrate the scope of incremental operating costs at the enterprise level, the average unit incremental costs shown in the above table was applied to rigid foam enterprises with HCFC-141b consumption of 5 metric tonnes (0.6 ODP tonnes), 25 metric tonnes (2.8 ODP tonnes) and 75 metric tonnes (8.3 ODP tonnes), for a two-year period, which represents the current duration of operating costs in the rigid foam sector. The resulting indicative IOC are shown in Table II.4 below:

Table II.4: Total incremental operating costs calculated over two years at the enterprise level (US $)

Technology	**Enterprise consumption (tonnes)**					
	5.0 metric (0.6 ODP)		**25.0 metric (2.8 ODP)**		**75.0 metric (8.3 ODP)**	
	Low	**High**	**Low**	**High**	**Low**	**High**
HFC-245fa (50%)	19,140	23,490	95,700	117,450	287,100	352,350
HFC-245fa (75%)	45,240	46,110	226,200	230,550	678,600	691,650
Water-based system	12,615	17,400	63,075	87,000	189,225	261,000
Methyl formate	(12,180)	(19,140)	(60,900)	(95,700)	(182,700)	(287,100)
Pentane	(10,875)	(19,140)	(54,375)	(95,700)	(163,125)	(287,100)
Cyclopentane	(10,005)	(15,660)	(50,025)	(78,300)	(150,075)	(234,900)

35. The following observations were made on the analysis of the IOC:

(a) Significant reductions in incremental operating costs can be achieved when some amounts of HFC-245fa are replaced with water in foam formulations. This, however, depends on the trade-offs between economy and foam insulation properties that the foam producer wants to achieve;

(b) The use of methyl formate results in incremental operating savings for both rigid and integral skin foam applications because of its comparatively low price and low level of usage[33];

(c) For rigid foam applications converting to pentane-based technologies has in the past (transition from CFC-11) resulted in significant incremental operating costs, even though the blowing agent had a relatively lower price as well as a lower usage rate of about half that of the HCFC-141b it would replace. This was

[32] Incremental operating costs associated with the phase-out of HCFC-22 may be higher than the estimated amounts presented in the table, as HCFC-22 is usually cheaper than HCFC-141b.
[33] The price is within the same range as the pentanes and 1 part HCFC-141b is replaced by 0.5 part methyl formate.

attributed to an increase in foam density, and additional maintenance, insurance and energy costs. However, the overall conversion for rigid foam applications from HCFC-141b to pentane based technologies still resulted in operating savings even after taking into consideration a 10 per cent increase in foam density and additional maintenance, insurance and energy costs, consistent with the methods of calculating the IOC of Multilateral Fund projects in this sector; and

(d) HFC-245fa and water-based systems, especially in integral skin foams where in-mould coating is used to improve the quality of the foam to meet market requirements, have the highest IOC.

36. Under continuation of current policies for calculation of incremental operating costs in this sector, IOC will be a major component of the overall cost of projects to phase out HCFCs and priority should be given to addressing issues linked to their calculation (i.e., duration, prices of chemicals and price structure, foam densities and other factors). During the phase-out of HCFCs the nature of formulations, particularly of HFCs and methyl formate, will play a significant role in determining the appropriate level of IOC for an enterprise. Hence project preparation may have to be approached somehow differently and with more involvement of systems suppliers at an earlier stage than before.

II.2 Special consideration of appliance and non-appliance foam applications

37. Under the Multilateral Fund, funding for phasing out CFC-11 used as a blowing agent has traditionally been done under the foam sector for enterprises manufacturing rigid polyurethane foam (known as non-appliance foam) with cost-effectiveness threshold of US $7.83/kg. It was however addressed under the refrigeration sector for enterprises manufacturing domestic and commercial refrigeration equipment (known as appliance foam) with sub-sector specific cost-effectiveness thresholds of US $13.76/kg for domestic refrigeration and US $15.21/kg for commercial refrigeration. The cost-effectiveness thresholds in domestic and commercial refrigeration sub-sectors consists of integrated values covering ICC and IOC in both foam and refrigeration manufacturing processes at an enterprise level.

38. A large number of Multilateral Fund projects under the domestic and commercial refrigeration sectors converted their foam insulation to HCFC-141b technologies, while the refrigerant component was converted to non-HCFC alternatives. Therefore, the next stage of the conversion of HCFC-141b to non-ODS alternatives will need to be addressed under the foam sector since there is no refrigeration component.

II.3 Conversion of HCFC-142b use in Article 5 countries

39. HCFC-142b and HCFC-22 have been used widely in non-Article 5 countries as replacements for CFC blowing agents since the early 1990s, particularly in extruded polystyrene insulation foam boardstock in the construction industry. Such HCFCs have been phased out in the majority of these countries[34].

[34] The main technologies selected are: HFC-134a, HFC-152a, CO2 (or CO2/alcohol) and isobutane. However, in Canada and the United States the phase-out has been more difficult because of particular product requirements, especially in the residential sector. The use of HCFC-142b and HCFC-22 is therefore expected to continue until 2010 in these countries.

40. Currently, the experience available in the Multilateral Fund for phasing out HCFC-142b/HCFC-22 is very limited, and only exists in relation to extruded polystyrene foam sheets and nets. However, over the last several years, the strong development of the insulation market in China, and to a lesser extent in a few other Article 5 countries, is driving the rapid introduction of extruded polystyrene enterprises using HCFC-based-technologies[35]. Further study of this foam sub-segment in relevant Article 5 countries needs to be undertaken in order to clarify the technological and cost issues involved.

II.4 Active participation of systems houses in the phase-out of HCFCs

41. In rigid and integral skin polyurethane foam production, most enterprises rely on chemicals that are commercially premixed with the blowing agent and other essential ingredients (premixed polyols) that are provided by companies known as systems houses. During the first phase of CFC phase-out, systems houses played a key role in the market penetration of HCFC-141b in Article 5 countries.[36] Funding was approved for a limited number of systems houses for producing suitable non-CFC based pre-blended polyols as well as providing technology transfer and training for their customers (i.e., downstream foam enterprises).

42. The transition from HCFC to non-ODS technologies could be challenging in Article 5 countries due to the current limited availability of HFCs, and potential handling and processing problems in some regions when using the newer technologies such as HFC-245fa. To mitigate such problems, systems houses in Article 5 countries may need to be encouraged or supported ahead of the project preparation phase to explore the possibilities of developing or optimizing suitable formulations for their local markets and possibly neighbouring countries where low levels of HCFC consumption would not make a systems house operation feasible.

43. Other critical areas that could be addressed through collaboration between local systems houses and the foam industry are the following:

(a) Reduction in the costs of foam formulations which are based on expensive blowing agents (i.e., HFC-245fa or HCF-356mfc), providing a competitive insulation product in cost-sensitive applications (e.g. by using a blend with hydrocarbon or co-blowing with water);

(b) Development and introduction of hydrocarbon-based premixed polyols, which could accelerate the move away from HCFCs in Article 5 countries; and

(c) Training and technical assistance to enterprises that selected HFC-based technologies to ensure that those enterprises conduct their production activities in a manner that poses the lowest risk to the global environment, such as limiting emissions of HFCs during foam production.

44. Demonstrations projects linked to interested systems houses could be one of the ways to promote the optimizing of systems and introducing phase-out technologies to the local industry.

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[35] This sector alone has an additional 20,000 metric tonnes per year consumption since previously assessed in 2001 (2006 Assessment Report of the Rigid and Flexible Foams Technical Options Committee).

[36] Eleven group projects involving 290 SMEs centred around local indigenous systems houses were approved in four countries at a total cost of US $7.2 million. The direct impact of involvement of the systems houses was a phase-out of over 1,300 ODP tonnes of CFC-11.

Systems house project to validate HCFC alternative foam systems

45. It is deemed essential for a successful Multilateral Fund financed HCFC phase-out programme that cost-effective, environmentally sound phase-out technologies that have been validated for application in Article 5 countries be available in a timely manner. Thus, the objective of the programme is to engage selected systems houses in Article 5 countries to validate new or considerably revised technologies for use in HCFC-phase-out projects. It is essential that the investigation time should match that needed to prepare the first HPMPs so that investment projects can benefit immediately from the validation exercise. Therefore the programme should start as soon as possible and include: emerging technologies that are non-ODS/low GWP as well as low cost options for conventional, non ODS/low GWP technologies.

46. Only the ICC of the participating downstream enterprises in the programme is proposed to be approved up-front as the IOC will be part of the investigations and paid during or following implementation of the programme. The cost of the project per system house is estimated to be in the range of US $145,000 and US $210,000 for work on non-flammable blowing agents and US $200,000 and US $320,000 for flammable blowing agents. The ICC range for each downstream enterprise converting to non-flammable blowing agent is estimated to be US $13,000 to US $20,000 and US 79,000 to US $165,000 for conversion to flammable blowing agent. The breakdown of the ICC is provided in Appendix II of Annex III to this document.

III. INCREMENTAL COSTS FOR PHASING OUT HCFC CONSUMPTION IN THE REFRIGERATION SECTOR

47. Currently, HCFC-22 is the predominant substance used in the refrigeration and air-conditioning sector in Article 5 countries. In 2006, 123 Article 5 countries reported an HCFC-22 consumption of 12,375 ODP tonnes (225,000 metric tonnes) used in the refrigeration and air-conditioning sector for manufacturing new equipment (mainly air-conditioners and to a lesser extent commercial refrigerators) and servicing existing equipment[37]. There are a number of other HCFCs that feature in the refrigeration sector, particularly HCFC-123 in chillers, and HCFC-124 and HCFC-142b as drop-in alternative refrigerants for CFC-12. Since it appears that there are no dedicated manufacturing capacities in Article 5 countries for products using these refrigerants, and since the quantities used are very small compared to HCFC-22, these HCFCs have not been further investigated in this paper.

III.1 Sectors and sub-sectors

48. In air conditioning, HCFC-22 has for more than 60 years been the predominant refrigerant, i.e. the refrigerant of choice for small, medium and large-size air conditioning systems, the latter with the exception of centrifugal chillers. It appears that almost all of the global manufacturing capacity for small residential air conditioning systems is concentrated in a small number of Article 5 countries (less than 15). The Secretariat has, for the purpose of this paper, defined the sub-sectors of room and split air conditioning, which also covers residential products; of commercial ducted and packaged air conditioning, that are medium-size, air-to-air systems used e.g. on the roof of larger commercial buildings; and HCFC-22 chillers, which have capacities below 500 kW used for air conditioning as well as for a number of process cooling

[37] It is estimated that an additional consumption of 300 ODP tonnes (5,500 metric tonnes) of HCFC-22 have been used as a blowing agent in combination with HCFC-142b for production of polystyrene foam.

applications in industry. The air conditioning sector is dominated by large industries with centralised manufacturing facilities.

49. Commercial refrigeration is the sub-sector with the most diffuse product range and variety as all refrigeration equipment used in commercial enterprises and not explicitly belonging to another sub-sector fall into this category. The products are largely, but not exclusively, used in retail, for the display and sales of refrigerated and frozen goods. Other applications range from water coolers to storage rooms for meat and dairy products. The wide range of applications and the catering to specific needs leads to a very dispersed industry with very few large but many medium and small enterprises producing highly customised products. There the borders between some parts of the commercial refrigeration sector and the service sector are blurred. Commercial refrigeration systems are probably manufactured in both every large consuming country as well as to some extent in most of the low consuming ones. HCFC-22 use in the sector has been driven, *inter alia*, by CFC-12 phase-out, and by the fact that service contractors and small companies have HCFC-22 infrastructure available for air conditioning servicing. These companies simplified their operations significantly by using the same refrigerant for both the service of air conditioning systems as well as for the assembly, charging and servicing of commercial refrigeration equipment.

III.2 Alternatives

50. For the different sectors, a number of alternative refrigerants are available. Technically, there are many possibilities to generate low temperatures for refrigeration. This paper concentrates on those that have, at the present point in time, a level of development and a field of application that suggest they might be candidates for HCFC-22 replacement in Article 5 countries in the mid-term, i.e. which might be relevant for Multilateral Fund projects related to the 2013 freeze or the 2015 consumption reduction step. These alternatives are essentially HFC refrigerants, hydrocarbons and ammonia. A detailed description of alternative technologies can be found in Annex IV.

51. HFC are refrigerants with similar general characteristics as CFC and HCFC; some important specifics of their technology are well known from the introduction of HFC-134a during the CFC-12 phase-out. The replacements for HCFC-22 which are most widely used in non-Article 5 countries all have a global warming impact (GWP) higher than HCFC-22. Most of these were actually introduced more than 12 years ago during the replacement of CFCs. Only HFC-134a has a lower GWP than HCFC-22 and is presently being used in particular for small capacity applications. For Article 5 countries, it appears that these applications cover a large share of the equipment likely eligible for funding. HFC-134a has, so far, not been used to replace HCFC-22, therefore cost data are not available. A number of HFCs have been developed to replace HCFC-22 in specific applications, and have been successfully and widely introduced in both non-Article 5 and Article 5 countries. Some, in particular HFC-410A, have characteristics that require substantial changes in equipment design, component manufacturing and service equipment due to their higher working pressures. There are a number of blends of HFCs and hydrocarbons available that allow simple drop-in conversion of HCFC-22 equipment to ODS-free alternatives to be carried out in many cases.

52. Hydrocarbons and ammonia are low-GWP refrigerants, which have continuously been used for many years. Both face safety related challenges. While the necessary technology to safely handle these refrigerants is well known, these characteristics lead to a higher incremental

capital cost at the time of conversion, as well as restrictions regarding the use of the related equipment. The main issues are:

(a) Hydrocarbons, in particular iso-butane, propane and propylene are, like HCFC-22, excellent refrigerants. Their flammability requires safe handling in manufacturing and during servicing, limits the amount of hydrocarbons charged per equipment and could impose restrictions with regard to the location of production facilities (e.g. outside residential areas) and, for larger systems, the equipment installed (e.g. ventilation requirements, separation from public). Hydrocarbons have been successfully used in refrigerators, where they are a fully established and widely used technology, as well as in small air conditioning and small commercial refrigeration equipment; and

(b) Ammonia technology has in the past been used in large refrigeration plants, in particular related to food processing and the chemical industry, and large chillers. The know-how needed to assemble and service ammonia refrigeration equipment is different from CFC/HCFC/HFC technology. Ammonia is presently used in a number of Article 5 countries, mainly because of historical reasons, but has proven difficult to introduce in countries where there are no prior uses. Similar to larger hydrocarbon systems, ammonia is typically restricted in terms of the location of equipment installed.

53. The available information regarding energy efficiency indicates that there is, for most relevant applications, both an HFC as well as a low GWP refrigerant which can lead to the same or better energy efficiency as provided by HCFC-22 equipment. This might, in some cases, require significant redesign or use of an optimised compressor, both resulting in some cost increases that can for the foreseeable future only be quantified on a case-by-case basis.

54. It is likely that at least for the initial stage of HCFC phase-out, the alternatives described above will represent all of the potential choices. Research regarding the development of low GWP refrigerants for the MAC sector with no flammability and low toxicity are reported, but presently it is unclear if and when they will be commercialised. More importantly, their applicability for HCFC-22 using sub-sectors is unclear, since these pose specific challenges for a replacement. CO_2 has been under development as an alternative refrigerant for the last 20 years, and is presently used in demonstration trials. Its main applications are small commercial systems and, in large, centralised supermarket systems, use for low temperatures. In small systems CO_2 requires a fundamentally different design and components, and has, due to its high pressure in this particular application, very different service characteristics than other refrigerants. In addition, the energy efficiency in comparison to HCFC-22 suffers significantly at high outdoor temperatures. It remains unclear if and under what circumstances the technology will be developed sufficiently to break out of its present niche market. For large low temperature systems, the technology used is only a relatively small variation of commonly employed technology, but the number of applications in Article 5 countries where it can be used to replace HCFC-22 is likely to be very limited.

III.3 Specific challenges in the service sector

55. Air conditioning systems are used throughout the world for comfort cooling. In some countries this might be restricted to uses like hotels and hospitals, in others include offices, and

domiciles might also be included. HCFC-22 is likely to be used in virtually all air conditioning systems from very small window units to 500 kW capacity systems. Given the need for servicing of these systems, it is likely that HCFC-22 is used by the service sector in essentially every Article 5 country.

56. While many air conditioning units do not require much repair, their large and rapidly increasing number will lead to an overall high service demand. The widespread use of HCFC-22 in commercial refrigeration is further boosting service demand. The general structure of the service sector is known from the phase-out of CFC-12. In the efforts to phase-out CFCs, activities in this sector have been grouped with, in particular, activities relating to legislation and enforcement of licensing and quota systems, as part of RMPs and TPMPs.

57. Since HCFC-based manufacturing in the foam and refrigeration sectors as well as solvent use of HCFC appears to be limited to a small number of countries, it is likely that a large number of Article 5 countries will have HCFC consumption almost exclusively in the service sector. This would include the sub-sector for assembly and charging of commercial refrigeration equipment. In contrast to the situation for CFC phase-out, when in most countries at least some manufacturing (e.g. soft foams) was CFC based and could be addressed to support the country in fulfilling its phase-out obligations, in the case of HCFCs there might be no such option for many Article 5 countries. During CFC phase-out it became evident that it is not possible to address and monitor the service sector on an enterprise-by-enterprise basis, chiefly because of the number of enterprises involved, their small size and their often informal structure. Therefore, CFC phase-out under the Multilateral Fund has mainly relied on supply restrictions through licensing and quota systems, while at the same time enabling the service sector to cope with dwindling CFC supplies through training in good practices and the provision of tools and equipment. The support by the Fund for the service sector has at the same time assured governments that supply side regulations would not lead to significant problems in the servicing of refrigeration equipment. The results of this approach have so far generally been good. The new challenge for HCFC phase-out is that supply side management has to start much earlier in the phase-out schedule, and to continue over a longer time-frame.

58. The demand for HCFC-22 in the servicing sector is related to the import of HCFC-22 air conditioning equipment by Article 5 countries, which subsequently creates a demand for HCFC-22 in the service sector. In order to facilitate subsequent reductions in consumption for the servicing sector, it appears appropriate to consider on a national basis whether it is possible to limit the imports of HCFC-22 equipment, in particular air conditioners, at an early stage. This would have repercussions on the timing of the demand for funding the conversion of in particular HCFC-22 air conditioner manufacturing facilities. Such facilities would need to be converted early on to enable them to supply other Article 5 countries with HCFC-free air conditioning equipment.

59. For low volume consuming countries to be able to decide on import controls, there would need to be sufficient support for their service sector to minimise HCFC-consumption and to enable appropriate handling of alternatives. It might therefore be appropriate to consider funding HCFC phase-out activities in the service sub-sector and related sectors (assembly, charging and end-user) in countries with predominant consumption in the service sector in or even before 2010, with a view to facilitating compliance with the 10 per cent reduction step in 2015.

III.4 Cost considerations

60. In order to develop an understanding of the possible costs related to HCFC phase-out in the refrigeration manufacturing sector, experts with experience in Article 5 countries were consulted in gaining an understanding of the structure of the sectors and sub-sectors. In a next step, an attempt has been made to define one or two typical HCFC-using enterprises for each sub-sector. Using the experience in the phase-out of CFCs, as well as services of experts, price lists and other available data, allowed for an estimation of the range of ICC and IOC for each of the alternatives. The approach is based on the assumption of replacement or upgrade of existing facilities during their useful life, as was the practice during the period of CFC phase-out projects. Since several of the sub-sectors have no guidelines to determine the duration of IOC payments, all IOC durations were normalised to one year, to facilitate fast calculation of the impact of the various longer or shorter IOC periods. Alternative technologies for the different sub-sectors, description of those sub-sectors, and conditions and results of the calculation of incremental cost resulting in indicative cost ranges are shown in Annex IV.

61. The approach of using a “typical” enterprise for the determination of incremental costs for manufacturing enterprises limits the uncertainty in estimating incremental capital cost per enterprise as the capital cost items will vary only within limits between different sizes of operations. But since the number of enterprises in a sector remains unknown, as well as the exact product ranges, extrapolation to determine conversion costs for entire sectors remains elusive for the foreseeable future. It should be noted that in case of CFC-phase-out, capital costs, but even more so the costs of items related to IOC (compressors, oils, refrigerants), usually decreased over time, and showed also significant variations in different markets.

62. The cost calculations for different model enterprises in the refrigeration manufacturing sector lead to the results presented in Table III.1. The operating cost are shown on an annual basis. If the Executive Committee would decide e.g. on a four-year duration, the values for the incremental operating costs shown in the table would increase accordingly. The calculation demonstrates that incremental operating costs of HCFC phase-out often take a larger share of the incremental cost than was typical for CFC-phase-out projects. It should be noted that those operating costs, being the only support under the Fund actually paid in cash, provide significant incentives to enterprises to convert their production early. On the other hand, the present way of the IOC provides an incentive to select the least economically sustainable technology, i.e. the option with highest per unit cost increase. The risks of problems during implementation, or of subsequent problems or retro-conversion to HCFC-22 is particularly high in such cases.

Table III.1: Incremental capital and incremental operating cost forecast for selected project templates in the refrigeration manufacturing sector[38]

Sector/ sub-sector and type of equipment	Annual production (unit/year)	ICC (US $)		IOC (US $)	ICC (US $)		IOC (US $)	ICC (US $)		IOC (US $)
		Max	Min	Annual	Max	Min	Annual	Max	Min	Annual
Air conditioning		**R410A**			**R407C**			**R290**		
Room and split AC	250,000	275,000	950,000	2,660,000	190,000	250,000	4,250,000	545,000	670,000	4,512,000
Commercial ducted and packaged AC**	1,000	245,000	145,000	36,600	120,000	80,000	28,500	n/a	n/a	n/a
	100									
Chillers	200	300,000	85,000	Tbd	n/a	n/a	n/a	n/a	n/a	n/a
Commercial refrigeration		**R404A**			**R134a**			**R290**		
Stand-alone units: commercial freezer	10,000	66,000	66,000	140,000	66,000	66,000	110,000	320,000,	320,000	230,000
Stand-alone units: vending machines	10,000							500,000	800,000	150,000
Condensing units	5,000	55,000	60,000	390,000	55,000	60,000	310,000			

63. The Secretariat has also attempted a preliminary estimate on the incremental costs for the service sector. The exact nature and volume of interventions in the service sector remains to be discussed, *inter alia* on the basis of the experience with RMPs and TPMPs. It appears that some major components of TPMPs, namely legislation and enforcement support, upgrading of technicians equipment and education as well as implementation monitoring, will continue to play an important role. The cost estimate assumes that it is necessary to provide additional funding for reviewing ODS legislation, as well as training programmes at a level of funding estimated according to the level of HCFCs consumption in the year 2006. The costs until 2015 were estimated to be between US $110,000 for the lowest consuming and US $13,940,000 for the highest consuming countries. The details of this estimate are presented in Annex IV.

IV. ENVIRONMENTAL ISSUES

IV.1 Decisions leading to the prioritisation of environmental issues

64. Decision XIX/6 calls for the 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." It also provides direction to the Executive Committee that when developing criteria for the selection of projects and programmes to be funded it "gives priority to cost-effective projects and programmes which focus on *inter alia*, 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"

65. The nature of the term 'gives priority' could allow for a number of interpretations, including priority in <u>timing</u>, in <u>absolute technology selection</u> or in <u>funding provision</u>. Priority in terms of timing could be taken as a 'given' assuming that climate beneficial technologies are already available. However, there are foreseeable conflicts if measures to address the 'worst first' requirements of decision XIX/6 in the context of ODS phase-out are less climate beneficial (or even result in a climate dis-benefit) than other options available.

[38] This table provides the incremental operating cost as per presently available data. It should be noted that there is not only a potential of variation of incremental operating cost, but also that the different technologies have different susceptibility for such changes. Consequently, the cost ratio between the different technologies will likely shift.

66. Where climate neutral or climate beneficial technologies exist which are affordable, it might be in the interests of the Executive Committee to discourage the adoption of technologies that lead to a climate dis-benefit by determining not to provide Multilateral Fund funding support at all. There are previous precedents within the Multilateral Fund history. However, such an approach would need to leave the enterprise or country with a sufficient number of funded technology choices available. In preparing this paper, the Secretariat believes that it needs further guidance from the Executive Committee about whether this type of prioritisation is appropriate at this point in time.

67. In this present analysis, no further consideration has been given to the treatment of ‘other environmental impacts’ which are inferred in decision XIX/6. In principle, these could include such items as VOC emissions leading to the formation of low level ozone. However, since these are often localised factors, it is expected that they will be applied at that level and will be part of the beneficiaries technology selection.

68. Since this paper is set in the context of a consideration of costs, the work reported herein relates primarily to how the funding approach of the Executive Committee might be used to encourage the adoption of technologies with maximum climate benefits. Decision XIX/6 itself notes the need to take into account “global warming potential, energy use and other relevant factors”. In assessing these indicators, the Secretariat has been keen to develop an approach that is sufficiently robust to act as a basis for a funding assessment, while ensuring that it is sufficiently sensitive to make meaningful climate comparisons. Additional information can be found in Annex V. Three basic methodologies have emerged:

(a) The adoption of a methodology based solely on global warming potential (GWP);

(b) The adoption of a methodology based in Life Cycle Climate Performance (LCCP); and

(c) The adoption of a ‘functional unit’ approach to life cycle evaluation.

69. In its initial review, the Secretariat did not consider that a methodology based solely on GWP would wholly address the mandate of decision XIX/6, since it would be unable to account for ‘energy use’ as required within the decision. In addition, the approach would need to account for differences in life-cycle containment practices and recovery options if it was to properly reflect a fair technology comparison. This would, by definition, bring it into the assessment of life cycle components.

70. As with all Life Cycle Assessment (LCA) processes, the development of a formal LCCP is data-intensive and requires the input of a substantial number of variables, not all of which might be known, either to the enterprise or a country, at the time of the funding application. Even if they were available, it would be a substantial and potentially impractical task for the Secretariat to cross-reference and verify that these assumptions were appropriate. The LCCP methodology is therefore seen as unsuitable as a basis for a funding assessment.

71. With the GWP and LCCP approaches representing the two extremes of the spectrum, the Secretariat has been assessing intermediate options which might overcome the disadvantages of each. This has resulted in the initial evaluation of a ‘functional unit’ approach which offers the robustness of a simplified and less data-intensive methodology, while ensuring that the key

criteria outlined in decision XIX/6 (GWP, energy use and other relevant factors) can all be taken into account. It should be stressed that the evaluation to date has been limited to only one sector and requires further methodological development to ensure applicability across the range of projects and programmes envisaged under decision XIX/6. Nevertheless, the Secretariat believes it appropriate to set out the basic methodology at this stage, and the funding options that could be derived from it, in order to received early feedback from the Executive Committee on the proposed approach.

72. The 'functional unit' approach focuses on a typical use of the substance in a sector, called 'element', in order to characterise the impacts related to that 'element' throughout its lifecycle. For example, the contribution of a foam to energy efficiency can be quantified per unit area for a typical building maintaining an average 10^0C temperature differential (thermal gradient) across a building element. This typical application is then used as a 'proxy' for the total activities in a sector. The purpose is not to calculate the precise climate impact for each and every application, but to characterise these impacts so they can be used for comparing technologies. In practice, the primary output would be a comparative assessment of lifecycle climate impacts taking into consideration the GWP of the substitute, the charge size, the energy used in operation, and the emission functions through the life-cycle. Alternative technologies can be evaluated against the benchmark of the most cost effective technology which completely phases out ODS and leads to a similar climate impact as the original HCFC technology.

73. This approach needs further development and evaluation across a wider range of sectors to provide assurance that the basic methodology can be applied more widely. The Secretariat therefore seeks the mandate to continue this work on the current path or, as revised by the Executive Committee, in order to present a more concrete set of proposals at the 57th Meeting.

V. INCENTIVES AND OPPORTUNITIES FOR CO-FINANCING

74. In preparing this paper, the Secretariat was requested to consider financial incentives and opportunities for co-financing, which could be relevant for ensuring that HCFC phase-out results in benefits in accordance with paragraph 11(b) of decision XIX/6 of the Parties to the Protocol. In the meantime, the 54th Meeting of the Executive Committee decided to adopt in its decision 54/39 guidelines for the preparation of HPMPs. These guidelines encourage countries and agencies to explore potential financial incentives and opportunities for additional resources to maximize the environmental benefits from HPMPs. Co-financing can be levied either on the level of individual projects or national plans, or on an aggregated level, or both. Decision 54/39 establishes the requirement to look into co-financing associated with individual projects or programmes.

75. For the purpose of this paper, the issue of environmental benefits is understood to refer to climate change and the mitigation of greenhouse gas emissions. Phase-out projects under the Multilateral Fund create mitigation of the emission of greenhouse gases on different levels. The reduction of the production of HCFC-22 will lead to subsequent reductions in the co-production of HFC-23, a potent greenhouse gas. The reduction of the production and consumption of HCFCs will lead to a subsequent reduction in emission of these substances which also have relatively high GWPs. The replacements used in the same applications would also be emitted, some of which might be potent greenhouse gases. Finally, HCFC use as a refrigerant and, to a certain extent as a foam blowing agent, are closely related to energy consumption, being in turn linked to carbon emissions.

76. For phase-out projects implemented under the Multilateral Fund to attract co-financing will require, as a minimum, a climate-relevant indicator as proposed in section V of this paper. This should provide a good starting point to assess the possible contribution of projects under the Multilateral Fund to the objectives of other funding mechanisms.

77. A number of such funding mechanisms exist which might be suitable to provide co-funds for Multilateral Fund projects. Among them are funds from beneficiaries, mechanisms based on traditional funding models, national energy efficiency projects from governments or from industry, and market based mechanisms. These currently represent the most likely sources of co-financing.

78. Traditional funding models include funds which are in their structure similar to the Multilateral Fund, i.e. a number of donors provide funding, which is available to a group of recipients, according to the definitions developed by a controlling entity. The GEF falls into this group, as well as other climate or environment related funds on an international, regional, and individual donor country level. At present, this group of funds is rapidly growing both in terms of volume as well as in the number of mechanisms. The criteria and access modalities to some of these funds might not be compatible with the objectives of the Multilateral Fund.

79. In some countries, governments or electricity suppliers are operating energy saving funds. Typically, such funds can be expected to be compatible with Multilateral Fund projects, but they do not appear to be common in Article 5 countries.

80. The market based mechanisms issue carbon credits or carbon emission rights that are meant to offset carbon emissions occurring elsewhere by emission reductions achieved under certain well defined projects. The income generated from such undertakings is dependent on the market price for such rights or credits at the moment of sale. These mechanisms work on the basis of actual emission reductions, and require environmental additionality, i.e., the projects must lead to emission reductions that would not have occurred otherwise. Activities to maximize the environmental benefits could be interpreted as being additional.

81. There is already experience regarding co-financing of individual projects or programmes available within the Multilateral Fund and its implementing agencies. Almost all Multilateral Fund projects have been approved as grants to beneficiary enterprises and institutions in Article 5 countries, with the exception of a small number of projects where co-financing was needed as in the case of chillers. The level of grants had been determined on the basis of an analysis of eligible incremental costs. Other, non-eligible or non-incremental costs have been paid, in many instances, by the beneficiary enterprises, sometimes with the assistance of cash funding provided through payment of incremental operating costs.

82. Examples of non-incremental costs paid by the enterprises are: construction costs associated with plant conversion and capacity increase or technology upgrades beyond the baseline level[39]. In addition, there is a large number of incentive programmes in the refrigeration servicing sector, which have been developed as part of RMPs, TPMPs and national phase-out plans, where partial funding is given to beneficiary end-users to retrofit or replace their ODS-

[39] These non-incremental costs have not been assessed and recorded by the Secretariat, and therefore quantitative information cannot be provided other than through the compilation of such additional information as might have been included in project documents.

based system to alternative refrigerants. These constitute examples for what could be seen as beneficiary co-funding in Multilateral Fund projects[40].

83. The centrifugal chiller replacement programme based on a funding window established by the Executive Committee at its 45th Meeting was approved on the understanding that there would be multiple benefits from replacing old CFC-based chillers by chillers with alternative technologies, and that funding would be disbursed only when co-financing had been assured[41]. Chiller projects were approved by the Committee at its 46th and 47th Meetings. A number of the projects were dependent on high beneficiary contributions, creating in essence an implementation facility similar to the incentive programmes mentioned above. Other projects were seeking to use other funding mechanisms such as the GEF, other environmental funds or funds from electricity companies associated with energy conservation. Funding from environmental funds started to materialise only 18 month after project approval, and are still not fully available. Funds from international finance instruments and electricity companies have not been available up to date, despite significant efforts.

84. It is likely that the projects would need to incorporate activities that might not be eligible under the present guidelines of the Multilateral Fund, while being funded from part of the co-financing received. This might, for example, be a technical upgrade of the technology used in air conditioners in order to achieve a higher energy efficiency. Similarly, restrictions might be imposed, e.g. in the sourcing of equipment, use of specific technologies, etc. It will be necessary to carefully assess, in light of the overall mandate provided by the Parties, under which conditions the amount of co-financing expected is significant enough to undertake the additional effort needed to fulfil these requirements.

85. In agreeing to the HCFC guidelines, the Executive Committee has already requested information regarding national or regional funding mechanisms that might be applicable. The premise of co-financing for individual projects and plans is therefore established.

86. From an assessment of the project process, it became clear that HCFC phase-out projects would need to be developed and implemented between 2009 and 2013 to achieve the 2013 and 2015 HCFC compliance targets. The experience in the implementation of chiller projects, with an important co-financing component, suggests that significant delays in HCFC phase-out projects are likely if they are conditional upon co-financing from regional or multilateral sources, creating potentially large challenges in achieving the compliance targets in 2013 and 2015. Given the time based reduction commitments of the Montreal Protocol, it is difficult for countries to risk having their projects delayed for the uncertain prospect of co- funding. Accordingly, if the slow rate of support by other funding entities were to continue, it would call into question the possibility of using other institutions to support Multilateral Fund activities.

87. Co-financing could also be accessed globally, i.e. beyond the co-financing of individual projects or programmes. For this purpose, both market based mechanisms as well as climate or environmental funds could be used. There might be some advantages to a parallel global approach, such as simplifying procedures and centralising the effort to leverage co-financing. In

[40] Under other funding mechanisms these costs are seen as "counterpart funding" or "co-funding".

[41] To allow the review of chiller projects under this funding window, the Secretariat undertook in documents ExCom/46/37, ExCom/47/20 and ExCom/47/21 an analysis of important aspects and relevant experience on co-financing that could be also valid for the mandate for this paper.

order to reduce the issue of project delay due to exploring co-financing possibilities, it would be possible for the Fund Secretariat to approach other institutions to see if clear methodologies and more streamlined mechanisms can be developed to enable the other institutions to top up Multilateral Fund ozone funding in order to achieve additional climate benefits. Exchange with other institutions could commence once discussion in the Executive Committee has progressed regarding certain issues raised in this document, in particular relating to cut-off date, second conversion and how to minimise other impacts on the environment.

88. Such activities might consist of the following:

(a) Identification of suitable and compatible regional or multilateral funding mechanisms;

(b) Assessment of the operational requirements associated, such as need for monitoring, requirements for additional activities or restrictions;

(c) Development of possible operational concepts for co-operation and necessary adjustments in project assessment, implementation, monitoring and evaluation.

89. The above points form a preliminary list, and would require close co-operation of the Secretariat and implementing agencies, under the continuous guidance and supervision by the Executive Committee. The Executive Committee might therefore wish to consider whether it wishes to further explore possibilities for co-financing.

VI. RECOMMENDATIONS

90. The Executive Committee might wish to:

(a) Take note of the discussion paper providing analysis of relevant costs considerations surrounding the financing of HCFC phase-out,

(b) Note the limited introduction of several of the HCFC alternative technologies available to date in Article 5 countries, the need to validate and optimize them to local conditions prevailing in Article 5 countries, and the wide variation in costs of replacement equipment and raw materials and, accordingly:

(i) Request the Secretariat to gather technical information related to HCFC phase-out in the aerosols, fire extinguishers and solvents on an on-going basis, to review any project in these sectors when submitted and to refer them as appropriate, for individual consideration by the Executive Committee; and

(ii) Consider the deferral to its first meeting in 2010 of any decision it might wish to take on policies for the calculation of incremental operating costs or savings from HCFC conversion projects, as well as the establishment of cost-effectiveness thresholds, in order to benefit from the experience gained through review of HCFC phase-out projects prior to that meeting;

(c) Agree that the technical information contained in document UNEP/OzL.Pro/ExCom/55/47, is sufficient to enable preparation, review and submission on a case-by-case basis of a number of stand alone projects (4 per region) for HCFC phase-out in the foam, refrigeration and air conditioning sectors with the aim of demonstrating the applicability of alternative technologies and facilitating the collection of accurate data on incremental capital costs and operating costs or savings as well as other data relevant to the application of the technologies, as per paras (d) and (e) below;

(d) Invite bilateral and implementing agencies, as a matter of urgency, to prepare and submit a limited number of time specific project proposals involving interested systems houses and/or chemical suppliers for the development, optimization and validation of chemical systems for use with non-HCFC blowing agents on the following basis:

(i) As part of the projects, following the development and validation process, the collaborating systems houses would provide technology transfer and training to a selected number of downstream foam enterprises to complete the phase-out of HCFCs in these enterprises;

(ii) Agencies are to collect and report accurate project cost data as well as other data relevant to the application of the technologies;

(iii) In order to be of benefit to the preparation and implementation of the HPMPs, as well as any stand alone projects these specific projects will be completed within a period not exceeding 18 months and a progress report on each of the two implementation phases as outlined in paragraphs (i) and (ii) above, will be made available to the Executive Committee;

(iv) Bilateral and implementing agencies and relevant collaborating systems houses are encouraged to addresses the technological issues surrounding preparation and distribution of premixed polyols containing hydrocarbon blowing agents;

(e) Consider inviting bilateral and implementing agencies to submit a limited number of demonstration projects for the conversion of HCFC projects in the refrigeration and air conditioning sub-sectors to low-GWP technologies to identify all the steps required and assess their associated costs;

(f) Continue its deliberations on policy relating to second stage conversions and determination of the cut-off date for installation of HCFC-based manufacturing equipment after which incremental costs for the conversion of such equipment will not be eligible for funding, with the view to concluding its considerations prior to submission of stand-alone projects which could commence at the 56th Meeting;

(g) Consider whether an approach of the type outlined in document UNEP/OzL.Pro/ExCom/55/47 provides a satisfactory basis for the prioritisation of HCFC phase-out technologies to minimise climate impacts as originally envisaged in decision XIX/6, and whether it wishes the Secretariat to continue with its evaluation in order to report in a more detailed fashion at a subsequent Executive Committee meeting;

(h) Consider the possibility for the Secretariat to approach other institutions with the objective of identifying suitable and compatible regional or multilateral funding mechanisms as sources for co-financing to top up Multilateral Fund ozone funding in order to achieve additional climate benefits and to provide a further report to a future meeting;

(i) Consider whether it wishes to examine, at a future meeting, options for giving priority to Multilateral Fund support for equipment replacement at a time when such equipment is reaching the end of its useful life to avoid premature retirement and destruction of expensive, fully functional infrastructure once the 2013 and 2015 compliance targets have been addressed.
