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DESK STUDY ON THE EVALUATION OF CHILLER PROJECTS

EXECUTIVE SUMMARY

1. There have been several categories of chiller projects funded to date: early specific retrofit or replacement projects, early projects that explored new and innovative approaches, those projects arising from decisions taken at the 47th and 48th Meetings of the Executive Committee and also chiller projects that are a component of national phase-out plans (NPPs) or terminal phase-out management plans (TPMPs).

2. Up to now, there has never been a systematic assessment of the various projects by the Multilateral Fund. This desk study has undertaken a review and analysis of the 90 or more project documents and reports available in the Fund Secretariat with a view to examining closely the attempts of the Multilateral Fund, *inter alia*, in setting up co-funding programmes with other institutions. The experiences gained, problems overcome and not overcome, as well as lessons learned are useful, independent of whether chiller replacement programmes would be considered in the future.

3. There are only a few country projects that have actually completed a significant number of chiller replacements to date through a grant and revolving fund structure, namely those in Mexico, Thailand and Turkey. These replacements occurred under varying conditions and mechanisms often with quite different domestic incentives. It is unclear what has determined the partial success or lack of success of these funds, or why they were appealing to part of the chiller owners in a country.

4. In 2005-2006, the Executive Committee approved US $15.9 million for chiller demonstration projects. If one studies the progress to date, no real stimulus can be found to continue such avenues, not even for exploring possible co-financing schemes. At this stage it is unlikely that these projects will give a good indication of what co-financing could imply.

5. A key objective of this desk study was to review available documentation on the experience of countries in pursuing the various financing sources, including barriers and impediments encountered. Information that has been obtained leads to some conclusions; however, there seems to be no consistent mechanism at all in Article 5 countries.

6. The limited experience to date indicates that in many countries energy savings combined with the declining CFC supply should be a sufficient stimulus to drive replacements. However, it is clear that this may not work in all countries, certainly not fast enough to eliminate CFC use in chillers by the end of 2009. It may well take many more years before all applicable centrifugal CFC chillers will have been replaced.

7. Although a large number of CFC centrifugal chillers are assumed to be still in operation in many Article 5 countries, and this number is estimated to remain large even after replacements have been done over the years, many issues still remain unclear:

(a) Which part of the total population of those chillers still needs replacement;

(b) How many chillers have been retrofitted or replaced globally without the intervention of financial instruments;

(c) How many CFC chillers are no longer in operation;

(d) How many chillers work under small annual running time percentages where financial savings over a short period would be substantially smaller than when working under full capacity during a large part of the year.

8. The latter may well have been and may well be a very important argument in getting centrifugal CFC chiller owners to convert or not. At relatively low running time percentages the financial savings

over a relatively short period of 2-3 years will be relatively small, much smaller than a loan to pay back 60-80 per cent of the total investment for a new centrifugal chiller plus necessary auxiliary equipment. It may well be that this issue has played an important role in the reluctance of many owners to subscribe to centrifugal chiller replacements. Replacement of a centrifugal chiller by a number of much smaller non centrifugal (screw and scroll compressor driven) units could have been a much more attractive choice (even using ammonia in some cases), but technical documentation on this specific issue is difficult, if not impossible to find.

9. With the CFC phase-out approach for Article 5 countries, it is also remarkable that countries do not report difficulties encountered in the total phase-out process due to the remaining CFC consumption in centrifugal CFC-based chillers. The issue is whether the few chillers that really are part of the problem are already covered under NPPs or TPMPs, or whether they are perceived as being outside the problem.

10. As a first preliminary conclusion, it could be mentioned that if bilateral or implementing agencies are able to identify centrifugal chiller projects for the Clean Development Mechanism (CDM) or Voluntary Carbon Standard (VCS), they should certainly continue exploring that avenue. It will, however, have administrative drawbacks and will be less appealing if the normal Certified Emission Reduction (CER) credits will be issued afterwards, which would need guarantees from governments or other entities up front to convince chiller owners to replace equipment.

11. Secondly, it seems logical not to pursue Multilateral Fund interventions or those of other financial entities to provide grants for revolving funds for the replacement of CFC chillers, unless Article 5 countries provide compelling evidence that the impact of such mechanisms could be supported by a list of chillers still in operation that would be targeted (including their operation history). Given all the constraints and the delays mentioned in this study, it is unlikely that this can be done.

12. The dimension of the problem, whether there still is a real problem or whether it has been largely resolved outside the perception of the Montreal Protocol financial framework is completely unclear. An approach to get a much better estimation of the reality is a *conditio sine qua non* for any further activities, if at all.

13. With the hydrochlorofluorocarbon (HCFC) phase-out approaching in Article 5 countries, the question arises whether replacements should be considered for HCFC-22 operated chiller equipment (equipment that is smaller in capacity than HCFC or HFC centrifugals), and in which manner this issue should be technically resolved. Without pointing at all kinds of concrete solutions at this stage, it can be mentioned that the equipment will and should be kept in operation for several years to come. Since technical solutions will be dealt with in non-Article 5 countries in the same manner, one may conclude that developments in both Article 5 and non-Article 5 countries should go in parallel, since similar issues will play a role in the near future.

14. Any HCFC-22 chiller phase-out should avoid the complexity of the perceived problem of CFC centrifugal chillers that need or needed replacement. As it is, the CFC centrifugal chiller issue acquired a life of its own in the Montreal Protocol arena, which did not contribute to further transparency. In a first instance, the best way possible seems to be to make HCFC-22 chillers an integral part of the HCFC phase-out process in a country, where the conversion of all types of equipment should be well described in the HPMP, while also setting clear targets.

I. Proceedings of the desk study

15. The preparation of a desk study on the evaluation of chiller projects is part of the monitoring and evaluation programme for 2008 and was confirmed by the 56th Meeting of the Executive Committee (decision 56/8). A key objective of the desk study and associated case studies was to explore further the

experience of these countries in pursuing the various co-financing sources and to analyse outcomes including barriers and impediments experienced.

II. Background and objectives

16. Chillers are applied in large commercial buildings and building complexes such as airports, hospitals, shopping malls, etc., as well as in industrial facilities, e.g., in the food and beverage industry, chemical processing, pharmaceutical formulation, the plastics industry, and manufacturing of semiconductors. Depending on the chiller types, the area of application, their capacity and the control system used, chillers require substantial investments. Such investments are utilised either to retrofit existing chillers or to replace old ones with new non-ODS chillers.

17. The population of chillers and its lifetime distribution in Article 5 countries is not known. CFC chillers have been produced in non-Article 5 countries until 1993-1994. Some developing countries may have produced CFC chillers much longer; there are anecdotal reports from refrigeration experts, which mention that new centrifugal CFC-based chillers have even been produced in 2007-2008. However, it is quite certain that the amount produced in the last decade is not large.

18. There are three basic ways in which Article 5 countries can and are meeting their obligations to phase out the consumption of CFC refrigerants used in the chiller sector. These are: retrofit, replacement and refrigerant containment. This last, containment, includes recycling and stockpiling in the country, by distributors or at the level of individual chiller owner, possibly combined with a virtual banking facility. Under the chiller replacement option, it was recommended that the Executive Committee approves the replacement of CFC chillers as a first priority of strategic options in ODS phase-out in the chiller sector, taking into account energy savings when calculating the incremental costs of replacement. Nonetheless, all of these project types are part of the inventory of chiller projects funded by the Multilateral Fund.

19. In principle, newer CFC-based chillers can be considered for a retrofit, since this provides an opportunity to decrease the operating and maintenance costs, while improving the chiller plant's performance. The selection of HFC or HCFC refrigerant depends on the type of CFC contained in the chiller being considered for a retrofit. Chiller retrofits cost 30-60 per cent less than chiller replacements, even though some parts of the chillers have to be replaced. Retrofits are an interesting conversion option; however, this is only the case when the compressor, which is the most expensive component of a water-cooled chiller, is in good condition, and when the old CFC-based chiller achieves a good level of efficiency, i.e., less than 0.75 kW/kW.

20. Retrofitting can never be successful if the CFC-based chillers are very old and are in a very poor technical condition, subject to frequent failures, and have a very high refrigerant leakage rate (thus operating at lower efficiency). The general rule is that chillers should not be retrofitted if they are older than 12-15 years.

21. A large variety of new types of centrifugal chillers are available and could potentially be installed, depending on technical conditions and regional specificities, including climatic conditions, the capacity of local engineering companies, technology diffusion, existing legislation and the banking system. Chillers could be operated in air-cooled or water-cooled versions. In particular, chiller types have to be selected according to their designated field of operation in industrial facilities or in the commercial and public-building sector. Water-cooled chillers incorporate the use of cooling towers, which improves the thermodynamic effectiveness of the chiller system as compared to air-cooled chillers. Water-cooled chillers will result in a constant temperature in the condenser that is lower than that in the case of an air-cooling system. Therefore, air-cooled chillers are substantially less energy efficient.

22. Studies were performed as of the mid-nineties regarding chiller replacements, e.g., by the World Bank's Ozone Operations Resource Group (OORG). Chiller replacement options were described in all subsequent UNEP's Technical Options Committee Assessment Reports on Refrigeration, Air Conditioning and Heat Pumps (RTOC Assessment Reports, 1994, 1998, 2002 and 2006). Chiller replacements and avenues of funding were also presented in a UNIDO report published in the course of 2008, which described the proceedings of a workshop held in 2007. Many more studies have been conducted and many workshops on chiller replacements have been held; the overall conclusion, however, is that the net outcome of all these efforts has not been impressive. This will be analysed further below.

23. There are no accurate and up-to-date statistics regarding the total number of CFC-based centrifugal chillers in all Article 5 countries. The report of the 2004 TEAP Chiller Task Force provides an estimate indicating that there were about 15,000 CFC centrifugal chillers still in operation in Article 5 countries; the total quantity of refrigerant installed in these chillers was estimated to be at least 6,000 ODP tonnes. On the basis of a CFC consumption analysis for centrifugal chiller servicing in several Article 5 countries, it could be concluded that leakage rates varied between 20 and 40 per cent for all installed chillers, where many chillers were already very old, i.e., older than 25-30 years. This implies that approximately 1,500 ODP tonnes of ongoing CFC consumption can be attributed to servicing these chillers, which would represent 5 per cent of the 2007-2008 remaining CFC consumption in the refrigeration servicing sector.

24. Assuming that the average age of CFC chillers would be between 15 and 20 years, many of these chillers could in principle remain in operation for another 10 to 20 years. However, this would require a large stockpile of CFCs under the assumption that the leakage rate would be 25 per cent (of a CFC inventory of about 500 kg for an average chiller). This makes the assumption of another 10-20 years of operation not very likely.

25. The estimate of 15,000 chillers from the 2004 TEAP Chiller Task Force report may well be an underestimate. It could be that the number for all Article 5 countries is somewhere between 15,000 and 20,000 centrifugal chillers. Of the total number of chillers it can be expected that a significant percentage is not in operation anymore. A large percentage may also have an annual running time percentage of less than 25 per cent per year, in which case it is questionable what the average annual leakage is and whether the chiller would really be effective once it is operated.

26. Annual running time percentages of less than 25 per cent yield relatively small electricity savings between an old and a new chiller (also very much dependent on the electricity price structure in a country), which will be a reason for chiller owners not to pay much attention to the replacement option. This in particular, if the replacement involves pay back of loans for the financing of the replacement.

27. It is also very unclear whether certain chiller owners have decided on a change of the CFC charge to a hydrocarbon charge, a so-called "simple retrofit". In the case of CFC-11, pentane or isopentane could be used, and for CFC-12, propane isobutane mixes or topping up with dimethyl-ether would work well. Safety issues play a role here, but are not discussed in this document. In a workshop on the HCFC phase-out, organised in Montreal in April 2008, there was one report of an Australian enterprise, which mentioned that hundreds of chillers apparently had been retrofitted to hydrocarbons in Asia.

28. In 1994, it was estimated that there were 80,000 CFC-based centrifugal chillers in operation in the United States of America[1]. Reports from 2003 indicated that about 30,000 CFC chillers had still not been retrofitted or replaced[2]; retrofit has become a less attractive option for these chillers. In the United States and other developed countries, production of centrifugal chillers was halted in 1993-1994; the ones still in operation are now more than 15 years old. After many years of operation, retrofits are reasonably

[1] Source: United States chiller manufacturers, material derived for the 2004 TEAP Chiller Task Force report
[2] Source: ibidem

expensive given the fact that the efficiency after retrofitting will be lower compared to the efficiency of new chillers. The costs for the retrofit outweigh the savings realized by new equipment.

29. On the basis of the above-mentioned figures it can be estimated that there must still be a significant number of CFC centrifugal chillers currently in operation in the United States (15,000-20,000). It can, however, be assumed that the CFC chillers left will have low annual running time percentages, which makes the difference in running costs with new products a lesser argument, and will not be a convincing argument for chiller owners to replace CFCs, as long as stockpiled CFC material will be available which, as reported, is the case in the United States[3].

30. As noted in document UNEP/OzL.Pro/ExCom/37/34, modern chillers are very efficient in terms of energy consumption in comparison to old chillers. A 35-45 per cent increase in efficiency is reported in case of a replacement of a 35 year old chiller. However, studies undertaken by the World Bank and others have indicated that, despite the short payback periods from energy savings, replacements are not happening in many Article 5 countries. Several of the Multilateral Fund sponsored chiller projects have experienced delays, reportedly due to difficulties associated with, *inter alia*, raising counterpart funding.

III. Projects carried out

31. The concerns and challenges associated with replacing CFC-based chillers have been recognized by the Executive Committee and many developing countries for a very long time. There have been several types of chiller projects approved:

(a) Early individual chiller projects (Mexico and Thailand) which tested innovative funding schemes; there were also a number of technical assistance and training projects (see part 2 of Annex II);

(b) Chiller retrofits and replacements as components of NPPs (Argentina, Brazil, Colombia, Ecuador, Malaysia, Mexico, Thailand and Turkey) and TPMPs (Bahrain, Honduras, Jamaica, Mauritius and Mongolia (see Annex II));

(c) At the 47th and later meetings of the Executive Committee, a series of demonstration projects were approved; these are being implemented by UNDP in Latin America (Brazil, Colombia, Cuba and the Bolivarian Republic of Venezuela);

(d) For UNIDO in Africa: Cameroon, Côte d'Ivoire, Egypt; in West Asia: Syrian Arab Republic; in Europe: Croatia and the former Yugoslav Republic of Macedonia; and by the World Bank under a global technical assistance project in China, India and the Philippines (see part 1 of Annex II).

32. As noted in document UNEP/OzL.Pro/ExCom/56/11/Add.1, three years after the approval of the funding for most of the chiller demonstration projects under the funding window of US $15.2 million for the chiller sector approved at the 45th Meeting of the Executive Committee, progress has reportedly been significant to some degree, but certainly not satisfactory. As compared to existing projects with full grant funding from the Multilateral Fund, the implementation of the chiller projects with counterpart co-financing was somewhat slower, but higher than the minimum required when the projects were approved. Despite the short preparation time, the agencies were able to advance projects as foreseen in the original submissions, but for a number of the projects even three years after approval the replacement of the first chiller had still not taken place. From the experience in industrialised countries, CFC-based

[3] Issue investigated by TEAP and the Multilateral Fund Secretariat in relation to supplies of recycled CFC material out of the United States to countries that were having a risk of non-compliance – May 2009.

chillers will likely continue to be used for some time to come, and they will need to be replaced to end the use of primarily CFC-11.

IV. Chiller project modalities

33. In earlier projects, several funding models have been utilized for chiller replacements. The Thai chiller programme with co-financing from the Global Environment Facility (GEF), the Mexican chiller project with co-funding from a local financing institution and the chiller replacement programme in Turkey as part of the CFC NPP have generated experiences and lessons learned on how the Multilateral Fund has worked with other financing institutions, what are the barriers and how they can be overcome**,** how they complement each other in their mandates, and how the operating procedures and administrative arrangements of different organizations have impacted the success, cost and timing of mobilizing co-funding. Some of these institutions are multilateral such as the GEF and others are private institutions that have different funding criteria and approaches.

34. In a progress report on chiller projects submitted to the 56th Meeting of the Executive Committee (document UNEP/OzL.Pro/ExCom/56/11/Add.1) the current situation of demonstration projects with respect to mobilizing of co-funding and converting chillers was described, based on information received from UNDP, UNIDO and the World Bank.

35. UNIDO has been able to mobilize co-funding from bilateral sources and chiller owners and has advanced relatively quickly. In Europe, of the 12 chillers targeted for replacement, 5 have been replaced, and work is in progress to replace 5 more. In the Syrian Arab Republic, all 3 chillers targeted for replacement were to be replaced in October 2008, and retrofitting, reportedly, is in progress for another 4 chillers. For UNDP, it took 19 months to obtain approval for co-financing from the GEF Council and the private sector. Final endorsement by the GEF Chief Executive Officer may still be pending. None of the 12 targeted chiller replacements have taken place yet.

36. The World Bank's global chiller project was approved for implementation in 7 countries (China, India, Indonesia, Jordan, Malaysia, the Philippines and Tunisia). The Bank's activities have thus far been focused on securing co-financing for the chiller replacement projects in India and the Philippines. The projects aim to provide incentives averaging 20 per cent to chiller owners, using funds from the Multilateral Fund and the GEF. In return, chiller owners will surrender the ownership of future carbon credits to the project. Under the CDM, the revenues expected from these carbon credits will be used as incentives for replacement of additional chillers, as well as to finance the project's management costs. A technical assistance component is included. A positive response has been received from chiller owners, financial institutions and other partners, but it needs mentioning that no conversions have taken place yet. Reasons can only be guessed, lacking technical and process information.

37. The total number of chiller replacement projects can only be estimated very roughly. From projects in Mexico, Thailand and Turkey, as well as from a number of smaller projects, the total number of replacements realised will be in the range of 250-350. A number of chillers will have been retrofitted or replaced without any intervention from the outside. With the total number of over 15,000 CFC centrifugal chillers estimated in 2004, the decrease in the total number cannot be significant, i.e., there must still be between 13,000 and 15,000 centrifugal chillers in Article 5 countries.

38. However, since Article 5 countries do not report difficulties in achieving the 2010 CFC phase-out, many chillers will not be operative anymore, there must have been more retrofits to unidentified chemicals or chillers and chiller servicing must be perceived as belonging to the CFC sector, which is actually difficult to understand. These issues make the whole remaining chiller replacement issue difficult to quantify. The last possibility is that the issue is not seen as urgent by chiller owners, because the replacement would not result in savings as anticipated, due to low running time percentages.

V. Barriers and impediments

39. All reports prepared in the 1995-2008 period have described barriers and impediments. In fact these barriers and impediments have not really changed over the years, which makes the chiller replacement issue also a very specific issue.

40. High initial investment costs, lack of a conducive government policy, deficiency in technical know-how and restricted access to financial support have been noted as creating barriers to chiller replacements, especially in the case of the more costly centrifugal types. Demonstration projects give local commercial banks, suppliers and project promoters more comfort and flexibility in implementing and financing such projects on a stand-alone basis.

41. To promote early phase-out of CFC chillers, it is important that two barriers – high up-front investment cost and perceived risk to realising savings through application of the new technology – be overcome.

42. Although savings typically relate to reductions in energy consumption, which alone make the replacement of old chillers an economically viable option, such replacement often does not take place without additional external stimuli. Possible reasons for the reluctance to replace old CFC chillers are:

(a) Lack of trust in the claim of lower-energy consumption;

(b) The building is being leased, thus investment and operating costs are covered by different entities;

(c) Non-availability of any investment budget (in particular in public buildings);

(d) Alternative investments offer a better return on investment than chiller replacement;

(e) Lack of perception of a pressing need to change; and

(f) Access to financing is difficult or costs of loans are prohibitive.

43. The World Bank found that a discount rate of 30 per cent modelled best the behaviour of the chiller owners in India. It was agreed that the country-specific and chiller-specific framework conditions regarding the benefits of chiller replacements should be taken into account in determining the project and country-specific level of funding needed to implement a chiller demonstration project. The World Bank's mathematical and business model currently represents the only accessible basis for such calculations. One important consequence is that chiller projects will need, depending on the conditions in the country, to receive funding between approximately 10 per cent and 25 per cent of the replacement costs of the chillers concerned. The remaining costs would need to be covered by income from other benefits of the replacements, in particular energy savings.

44. The review of the documents revealed the following additional barriers:

(a) Lack of awareness of existing regulation among end users. End users are often unclear on how exactly government regulations apply to chillers and specific installations/businesses. This creates a disincentive to change the CFC chillers prior to the end of their economic lives;

(b) High investment cost. The public sector is typically dependent on budget appropriations for its capital expenditure, and therefore unlikely to have upfront capital for chiller replacement;

(c) For countries that are in debt, there are usually heavy restrictions on obtaining new financing. The public sector is often not allowed to lease chillers and is also not allowed to finance them privately;

(d) When the price of electric power is very low there is insufficient evidence to create a compelling case for chiller conversion especially for small chiller owners in the public sector. Users that receive even lower industrial energy rates will also not see the economic incentive for conversion even though CFCs will not be available in future;

(e) When the running time percentage of the chiller is low (maybe combined even with a low price of electric power), there is insufficient evidence to create a compelling case for chiller conversion. Users will not perceive an economic incentive or will see difficulties if loans have to be paid back over a short period, even though CFCs will not be available in future;

(f) The private sector is more likely to invest in revenue-increasing rather than cost-reducing activities. In addition to the high cost of equipment, private sector chiller owners also have to pay extremely high taxes on imports, in some cases amounting to almost 45 per cent of the cost of the equipment.

VI. Delays in chiller project execution

45. Many chiller projects have experienced delays (for example, India, Malaysia, Thailand, the Bolivarian Republic of Venezuela and Viet Nam) and the reasons noted in the documentation vary considerably. Examples are:

(a) Lack of flexibility in project design;

(b) The requirements for several individual project documents for owners of multiple chillers;

(c) No technical assistance budget available although needed;

(d) Too complex project guarantee requirements. In Thailand this reason was cited as the reason why several project owners chose to undertake additional chiller conversions without using the project window;

(e) Lack of confidence in new chiller technologies;

(f) Unclear direction on how to scrap and/or dismantle existing chillers;

(g) Many enterprises expressed reluctance to invest as long as CFCs were still available, so restrictions on CFC supply must be required;

(h) Delays associated with needed building modifications to accommodate the replacement chillers;

(i) Delays associated with the inadequate assignment of resources (not enough persons working on the project) for the chillers project;

(j) Lack of inter-institutional agreements (for example, Mexico);

(k) Chiller replacement was considered by some as a second priority. Hotels would invest first in convenient facilities, room decoration and renovation. It was reportedly difficult to persuade enterprises in this sector to join the programme;

(l) Lack of a policy driver for ensuring a transition to new chillers, from either the ODS or energy efficiency perspective. No legislation and/or regulations were in place requiring that CFC chillers be replaced or facilitating replacement by non-CFC chillers;

(m) Delays in negotiating the default clause;

(n) Individual loan schemes (for example, the World Bank) were new and required new guidelines and regulations for the implementing agencies because the programme had to deal with many individual enterprises and former guidelines were not applicable;

(o) In the case of Thailand, the Ministry of Energy offered several financial subsidy schemes to promote energy efficiency targeted, *inter alia*, at replacing old CFC chillers with new energy efficient non-CFC chillers. These incentives were considered by the private sector more attractive than the ones offered by the Multilateral Fund project because the interest rates were very low with longer repayment period and with no requirements to dismantle the old CFC chiller and install a data logger to the new chiller.

46. For the chiller sector, seven investment projects have been approved and completed; only US $1,473,219 (54.3 per cent) of the total funds approved had been disbursed by the end of 2007. In addition, 18 non-investment chiller projects (demonstration and technical assistance projects) were approved for US $15,337,314. Six projects have been completed at present and 8.6 per cent of the approved funds has been disbursed to date. In addition, chiller replacements have been funded as part of CFC NPPs or TPMPs in several countries (for example, Argentina, Mexico and Turkey). It shows that this type of projects is difficult to execute even once approved and serious delays are met while all kinds of parameters change, etc. The table below shows the progress as mentioned.

APPROVED CHILLER PROJECTS UNDER THE MULTILATERAL FUND

Agency	No. of approved projects	No. of completed projects	Total funds approved (US $)	Total funds disbursed (US $)	ODP approved (tonnes)	ODP phased out (tonnes)	PCRs received
Investment projects							
Total	**7**	**7**	**2,708,783**	**1,473,219**	**65**	**67**	**6**
IBRD	4	4	1,803,443	604,496	55	55	4
Bilateral	3	3	905,340	868,723	10	11	2
Non-investment projects (demonstration and technical assistance)							
Total	**18**	**6**	**15,937,314**	**1,319,926**	**105**	**4**	**5**
IBRD	2	1	7,590,629	706,017	105	4	1
UNDP	5	1	4,059,353	75,000	0	0	0
UNEP	1	0	200,000	0	0	0	0
UNIDO	3	0	2,402,535	33,839	0	0	0
Bilateral	7	4	1,684,797	505,070	0	0	4

Source: 2007 Progress Reports

VII. Financing and co-financing centrifugal chiller projects

47. There are several methods for funding chiller replacements, which have strong link to energy efficiency improvements. They can be funded as demonstration projects under the Multilateral Fund or similar mechanisms. Replacements can also be done using CDM or VCS funding. Both the CDM and the

VCS apply the same procedures and methodologies, which are extensively reviewed; they issue carbon related credits, where the value of the credits is higher from the CDM than from the VCS. The VCS operation, however, is more flexible.

48. Chiller replacements are eligible as small-scale CDM projects under the Kyoto Protocol. One appropriate way to use the CDM mechanism for chiller replacements in a country is through a programme of activities because due to high initial development and transaction costs, a CDM project based on a single chiller replacement seems not to be feasible. The energy-efficiency gains achieved result in CERs that can be sold to contribute to the financing of the chiller replacements. To achieve this contribution, a chiller operator must use the services of a competent firm to prepare the necessary documents for the CDM Executive Board of the Kyoto Protocol, and the respective Designated National Authority (DNA) in each country.

49. This approach results in a transaction cost based on each single project and consists of the cost of developing the project document, the validation and verification costs as well as the share of proceeds as required by the Executive Board for project registration and the cost of CER issuance. High transaction costs calculated on the basis of a single project can render the implementation of individual projects uneconomic. Furthermore, the volume of CERs achieved by one chiller under typical energy-efficiency gains would not be marketable.

50. The most concrete relevant GEF project is the "Accelerated Chiller Replacement Program" prepared by the World Bank. The project is designed to secure the early replacement of energy-inefficient, large-sized chillers (capacity 100 tonnes refrigeration or more) in India. Further details on the approved baseline and monitoring methodology "Power saving through replacement by energy efficient chillers" can be found on the UNFCCC website, http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

51. For the projects arising from decisions at the 47th and 48th Meetings of the Executive Committee, co-funding is being contemplated or has occurred, to date, through different sources:

(a) The GEF was proposed as a funding source for the global chiller replacement project and the projects in Brazil, Colombia and the Caribbean Region;

(b) Carbon financing was proposed for the global chiller project;

(c) Funds from electricity service companies were proposed for the project in Brazil;

(d) Funding from the Canadian International Development Agency (CIDA) for the project in Cuba;

(e) The French Global Environment Facility in cooperation with UNIDO;

(f) Funding from internal funds of implementing agencies (for example, an internal UNDP fund for the Caribbean and Cuba); and

(g) Funding from GTZ for the replacement of government chillers in Mauritius.

52. A number of pilot schemes and demonstration projects were funded by the Multilateral Fund to show the technical feasibility to generate energy savings and the economic viability to mobilize resources external to the Multilateral Fund to duplicate the pilot projects. In earlier projects, several funding models have been utilized for chiller replacements. The Thai chiller programme with co-financing from the GEF, the Mexican chiller project with co-funding from a local financing institution and the chiller replacement programme in Turkey as part of the CFC NPP have generated experiences and lessons learned on how the Multilateral Fund has worked with other financing institutions, what are the barriers and how they can be

overcome**,** how they complement each other in their mandates, and how the operating procedures and administrative arrangements of different organizations have impacted the success, cost and timing of mobilizing co-funding. Some of these institutions are multilateral such as the GEF and others are private institutions, which have different funding criteria and approaches.

53. Energy service companies (ESCO) are a very good source of financing for energy efficiency for their clients, because facilities pay no money up front. However, the ESCO approach relies upon two elements in any country: rule of law and access to financing. A strong legal environment is necessary to protect the energy service company from the risks it assumes by financing the projects.

54. The energy service company first identifies potential savings and then signs an energy performance contract**,** with the owners (its client). Under the contract, the energy service company agrees to reduce energy use, and the client agrees to pay it a certain amount of the savings from the project. The energy service company then implements the project, recoups its investment (and realizes some profits) from the savings, and the client continues to save energy after the contract has been concluded. To be called an energy service company, a company must be able to identify and carry out energy-saving projects and to finance its investments. The financing component is what makes an energy service company different from a contractor or energy auditor. In most cases, however, the energy service company itself does not have the equity to invest in a series of large energy-efficiency projects. Therefore, it needs third-party financing to realize the project. Large equipment vendors may use an energy service company as a means of selling their equipment while keeping risks and debt on that company's books, rather than on the books of the parent company.

55. The ESCO approach has been discussed for chiller replacement projects in Brazil for several years now. However, so far no concrete results regarding any implementation have been documented.

56. Projects, which replaced a significant number of large centrifugal chillers using a small grant (20-25 per cent of the total cost) and co-funding through a revolving fund were implemented in Mexico, Thailand and Turkey.

57. For Mexico, the first phase was co-financed nationally with matching funds through an energy-saving fund. A second phase was approved as part of the 2005 annual work programme of the NPP. Phase I of the project was targeted towards a particular region in Mexico, replacing 12 centrifugal chillers out of Mexico's estimated total of 1,500 chillers. Phase II targeted another 10 chillers. Both phases are ongoing, i.e., more chillers will enter the programme until the funding is completely used up.

58. The chiller project in Thailand targeted 24 of Thailand's estimated 1,400 chillers. The stated purpose of the project was to test the feasibility of using a revolving fund. The demonstration of savings achieved facilitated the creation of similar but larger loan programmes in Thailand driven by national banks and centrifugal chiller manufacturers without the involvement of the Multilateral Fund. The World Bank has already returned part of the funds to the Multilateral Fund as this was envisaged from the onset. It is difficult to estimate at present what the net result of the replacement project is. From the information available, it does not seem to replace a significant percentage of the country's chillers.

59. The Government of Turkey is using co-financing from the chiller owners for the implementation of a chiller replacement programme using a revolving fund mechanism. A chiller sub-project was integrated into the CFC NPP, creating an interest-free revolving fund using a large share of the total funding available under the early annual tranches of the NPP. Forty chillers at 21 firms have been reportedly replaced to date through the project. Similar to Mexico, the number of chillers to be converted is open until the depletion of funds. The target is the replacement of 65-80 chillers, although it is not clear whether this will be achieved.

VIII. Experiences in chiller replacements in Turkey

60. Turkey is a specific example for the CFC phase-out because the country was one of the first to convert refrigerator manufacturing from CFCs to HFC-134a in 1992-1994 with Multilateral Fund support. It implemented early a sector-wide project and started a revolving fund mechanism in the early stages of the CFC phase-out. The Government of Turkey decided to phase out the use of CFCs under an accelerated schedule, and Turkey reported zero CFC consumption for the year 2006.

61. The key players regarding the chiller sub-programme were: the Ministry of Environment and Forestry (MoEF), the National Ozone Unit (NOU), which is part of an integrated climate change unit, the Technology Development Foundation of Turkey (TTGV), the chemical and equipment suppliers, the service technicians, KOSGEB-Small and Medium Industry Development Organization and the Customs officials. It was decided that TTGV would be the responsible body for the management of the revolving fund, beneficiary selection and general implementation procedures. Selected sub-projects were to be approved by the World Bank.

62. It was reported that some difficulty was experienced in convincing chiller owners in Turkey to convert their chillers due to concerns regarding the need for, and impact of, a very high initial investment and commercial interest rates (typically 25-30 per cent). To overcome these problems the chiller programme (revolving fund) in Turkey was designed to offer 75 per cent as an interest-free loan and 25 per cent as a grant. The loans are/were to be paid back in 5 instalments at six-month intervals with payments commencing upon completion of the installation and start-up of the equipment (interest rate being 0 per cent). This is far more favourable than the interests asked by banks on the investment market, so this has substantially influenced the picture.

63. A consultant was contracted to undertake a survey with a view to defining the chiller population. As per his survey conducted during spring of 2003, the consultant identified chiller owners through chiller suppliers. He reported that there was an estimated total of 1,400 chillers with 150-200 large CFC-based centrifugal chillers. He identified 25 CFC-11 chillers, 48 CFC-12 chillers and 8 chillers using CFC-113 or R-500.

64. Two seminars on chillers were held in Antalya and Istanbul in June 2003 aimed at providing information about the chiller replacement project and to determine the conditions and possible receptivity to a revolving fund approach as well as to receive applications from potential chiller owners. Both seminars had 21 participants from chiller owners and suppliers.

65. The chiller sub-project was initiated and used a front-loaded multi-year, performance-based funding to create the revolving fund in accordance with grant agreements signed with the World Bank and the Government of Turkey – dated 24 January 1994, No. 21934 – and the World Bank and TTGV – dated 6 November 1995, No. 21942. The intent was to impose minimum costs to other components of the CFC phase-out programme and to integrate the revolving fund into Turkey's CFC NPP. It was planned from the onset to use monies returned to the fund for remaining conversions after the completion of the project.

66. As noted, the key player in the implementation of the revolving fund in Turkey was TTGV. A specific revolving fund project cycle administered by TTGV included the following specific items:

(a) The chiller supplier makes potential beneficiaries made aware of revolving fund;

(b) The approval of costs and the grant portion (25 per cent) and the interest-free loan portion (75 per cent) are provided by TTGV and paid to the beneficiary upon submission of the invoice;

(c) The measurements of the old and new chiller are done by TTGV;

(d) The beneficiary pays 5 per cent of the total project costs to TTGV.

67. Regarding the establishment of the fund management modality, three contracts were signed: the World Bank and the Undersecretary for the Treasury to Turkey, the World Bank and TTGV (the financial intermediary) and the Undersecretary for the Treasury and TTGV. In accordance with these contracts, TTGV was designated as the responsible body for management of the funds, which are kept in a special bank account.

68. As noted above, TTGV receives a 5 per cent fee from the project owner. For TTGV this is a standard procedure and the fee is to cover the cost of project monitoring and is based on a contract signed with the beneficiary. Monitoring includes both technical and financial monitoring, including the management of pay backs.

69. There did not appear to be any comprehensive strategic plan for total chiller phase-out developed by Turkey, other than the establishment of the revolving fund. The survey data did not produce any data as to what percentage of the chillers is in the public versus the private sector. It was reported however, that some public sector chiller operators indicated they would only participate if there was a 100 per cent grant as they lacked monies in their public sector budgets to upgrade the chillers.

70. The first round of chiller replacements was completed in 2003 at which time only about 39 chillers were identified. A survey was then conducted which identified additional CFC chillers. Some 65-80 chillers, located in 50 firms were then targeted for this project but at the time of closure the project facilitated replacement of just 40 chillers in 21 firms.

71. For the second round of chiller replacements, selection criteria only included:

(a) CFC chillers using turbo/centrifugal compressors are eligible, since the energy saving potential is related to the improved design of these compressors;

(b) Chillers that are in operation are eligible for financial support (chillers that are not operating are not financially supported).

72. Regarding chiller efficiency it was decided that the main aim of the project was to apply technical solutions that would ensure energy savings. Therefore, energy efficient solutions were to be given priority. Chillers having constant annual load profile were to be evaluated only on the coefficient of performance (COP), whereas chillers with seasonal load profile were to be evaluated on both COP and non-standard part load value (NPLV).

73. The Technology Development Foundation of Turkey indicated that the original list of chillers included 64 companies/institutions, 15 of which were either public institutions or public companies. During the outreach phase, these 15 institutions were contacted and inspite of all the effort made it was impossible to persuade the authorized persons to participate.

74. It was further noted that the budget of the chiller project was US $4 million and it was clear to TTGV that only a limited number of chillers could be replaced. TTGV decided that private sector beneficiaries who could comprehend the situation and take action quickly would be eligible (the preferred beneficiaries). It was also pointed out that if a specific focus had been given to the public chillers in the second phase, a special streamlined public beneficiary procurement procedure would have been needed. Furthermore, TTGV, MoEF and the persons met were unable to offer any insight as to whether replacements were occurring outside the project and if so, whether this was simply because they were unaware of the revolving fund.

75. The chillers were converted in Turkey without a clear strategy, and the impression was obtained that the chillers would have been replaced by the owners anyhow. The grant offer therefore may have not been the main driver. In this case of a revolving fund, most of the replacements were done outside the terms of reference, i.e., replacements of chillers were done together with complete renewal of auxiliary equipment leading to much higher capital requirements, but with less or virtually no difficulties to pay back the loans since the interest rate that was applied was 0 per cent.

76. The chiller revolving fund project was completed on 31 December 2008 (the financial aspects on 1 April 2009) resulting in the replacement of 40 chillers in 21 firms. There is now US $2.5 million from the fund that the MoEF has yet to decide how best to disburse. As a result, progress has been relatively good, but it is difficult to judge whether the project will ever have a “total” replacement result.

IX. Experiences in chiller replacements in the former Yugoslav Republic of Macedonia

77. The chiller project component in the former Yugoslav Republic of Macedonia is part of the UNIDO-assisted demonstration project with the aim of phasing out 28 ODP metric tonnes of CFCs by replacing 12 CFC-based centrifugal chillers in 5 countries in the Eastern Europe and Central Asia Network.

78. A total of 23 CFC-based centrifugal chillers were identified, assuming that this was at least 95 per cent of the chillers in the country. These 23 chillers are located in 7 enterprises only. These are in buildings and companies that, for the most part, were government owned and have now lost their markets (their markets were the former Union of Soviet Socialist Republics) and are therefore dormant. Current data suggests that only 5 of the 23 chillers are in use, two of which were replaced through the Multilateral Fund project.

79. In general, all types of chillers in the former Yugoslav Republic of Macedonia, especially the centrifugal type, receive low quality maintenance and there is reportedly a lack of preventive measures to avoid leakage. Only a few personnel were trained by equipment supply companies at the time of chillers purchase, i.e., some 25 to 35 years ago. Therefore, today's personnel are not well versed in proper maintenance and servicing.

80. Also, many owners, reportedly, do not set aside money for regular maintenance, spare parts and timely service in order to “save money”. Many owners reportedly feel it is too expensive to call a company specializing in servicing centrifugal chillers. Consequently, many chillers are in a poor working condition and with low COP, and experience frequent failures and a high leakage rate (up to 100 per cent).

81. In general, the Multilateral Fund support included approximately 60 per cent (or less) of the total project cost. The contributions of the beneficiaries varied depending on whether pumps and/or the water cooling systems needed replacement and whether changes to the buildings were required to accommodate the new chillers.

82. Interestingly, the main driver in the former Yugoslav Republic of Macedonia (as reported by the beneficiaries when interviewed) was the severe leakage rates and associated maintenance costs coupled with the declining availability of CFCs as a cause for future concern. Beneficiaries reported that they would have replaced the chillers regardless of the Multilateral Fund funding; replacement plans were already underway when beneficiaries were made aware by the equipment suppliers of the Multilateral Fund grant possibility. The grant offer through the Multilateral Fund was reported as fortuitous but not the main driver.

83. Delays were experienced and were due mainly to problems with contractors in relation to modifying buildings to accommodate the new chillers.

84. With regard to the project funding mechanism, UNIDO, reportedly, considered the possibility of a revolving fund, but this was not possible because there was not sufficient time remaining prior to the phase-out date to allow for any rollover of funds.

85. With regard to financing options, owners of the selected project sites were reportedly contacted by the Ozone Unit to obtain their commitment for co-financing. The percentage of co-financing was also reportedly discussed and agreement reached on the Multilateral Fund support being used to purchase the equipment and the beneficiaries contribution being the assumption of all other infrastructure and related costs. UNIDO negotiated Multilateral Fund support levels and beneficiary contributions on a case-by-case basis keeping in mind the overall 60/40 per cent overall project design objective.

86. Funding from the Multilateral Fund ended up covering the full purchase price of the replacement chillers with all other costs born by the beneficiary. Not only chillers were replaced, but also all auxiliary equipment and building adaptations were made. The infrastructure costs born by the beneficiaries (piping, pumps, building alterations, etc.) varied markedly from case-to-case and were at least in one case, several times the cost of the chiller replacement.

87. After the replacement of the two chillers, the completion of a strategic plan that will address the phase-out of all of the remaining CFC chillers is still underway. Estimates for completion are difficult to make.

X. Key observations

88. CFC centrifugal chiller replacements in Article 5 countries have been discussed for a considerable time now, barriers and impediments have been established, working schemes to be applied in replacements have been conceived and approved. However, serious delays are still encountered, which raises the question how and where to proceed after the CFC phase -out in Article 5 countries.

89. Since new chillers are considerably more efficient than older ones, electricity savings and related financial savings are substantial. However these savings will depend on the electricity price strategy of a country and particularly on the annual running time percentage of a chiller.

90. Many demonstration replacement projects have been approved; completion of projects, however, has suffered delays and several projects will not be adequately completed.

91. Projects under the CDM – or under the VCS which is a similar instrument – can be carried out but will incur big transaction costs. This can only be feasible if a significant number of single projects are realised under a programme of activities. Compared to a grant or grant/loan structure, the reimbursement through CERs will be rather cumbersome to the separate chillers and will not be appealing to many chiller owners. This would necessitate a sort of financial intermediate in the country, which would complicate structures.

92. Experiences with revolving funds, which start with relatively small grants and loans to be paid back within 20 years, have been partially successful. However, if the experiences from all revolving funds are summarised, there are no conclusions that can be drawn on why certain revolving funds were more successful than others. In countries where the revolving funds have been operational, not all chiller owners have been convinced of the success formula of such a set-up. It seems impossible in a country to replace all centrifugal CFC chillers using a revolving fund, even if its structure is made very flexible and great efforts are invested in public relations and outreach activities.

93. Although a number of CFC centrifugal chillers are assumed to be still in operation in many Article 5 countries, and this number is estimated to remain large even after replacements done over the years, many issues still remain unclear:

(a) Which part of the total population of those chillers still needs replacement;

(b) How many chillers have been retrofitted or replaced globally without the intervention of financial instruments;

(c) How many CFC chillers are no longer in operation;

(d) How many chillers work under small annual running time percentages where financial savings over a short period would be substantially smaller than for full load during large part of the year.

94. The latter may well have been and may well be a very important argument in getting centrifugal CFC chiller owners to convert or not. At relatively low running time percentages the financial savings over a relatively short period of 2-3 years will be relatively small, much smaller than a loan to pay back 60-80 per cent of the total investment for a new centrifugal chiller plus necessary auxiliary equipment. It may well be that this issue has played an important role in the reluctance of many owners to subscribe for centrifugal chiller replacements. Replacement of a centrifugal chiller by a number of much smaller non centrifugal (screw and scroll compressor driven) units could have been a much more attractive choice (even using ammonia in cases), but technical documentation on this specific issue is difficult, if not impossible to find.

95. With the CFC phase-out approach for Article 5 countries, it is also remarkable that countries do not report difficulties encountered in the total phase-out process due to the remaining CFC consumption of centrifugal CFC-based chillers. There is an issue of whether the few chillers that really are part of the problem are already covered under NPPs or TPMPs, or whether they are perceived as being outside the problem.

96. Experiences from countries such as the former Yugoslav Republic of Macedonia are illustrative where chillers were planned to be replaced through a grant-loan structure. But in this case chiller owners would have done the replacements regardless due to the high servicing costs and the long off-periods because of technical failure of old chillers, as well as the reducing supply of CFCs for servicing.

XI. Conclusions

97. As a first preliminary conclusion, it could be mentioned that if bilateral or implementing agencies are able to identify centrifugal chiller projects for the Clean Development Mechanism (CDM) or Voluntary Carbon Standard (VCS), they should certainly continue exploring that avenue. It will, however, have administrative drawbacks and will be less appealing if the normal Certified Emission Reduction (CER) credits will be issued afterwards, which would need guarantees from governments or other entities up front to convince chiller owners to replace equipment.

98. Secondly, it seems logical not to pursue Multilateral Fund interventions or other financial entities to provide grants for revolving funds for the replacement of CFC chillers, unless Article 5 countries provide compelling evidence that the impact of such mechanism could be supported by a list of chillers still in operation that would be targeted (including their operation history). Given all the constraints and the delays mentioned in this study, it is unlikely that this can be done.

99. Thirdly, it may be worth considering in which ways Article 5 countries could accomplish necessary replacements after the 2010 phase-out, possibly through a combination of grants, short and long term loans that would fit in future national climate change mitigation activities. A structure that provides for national climate awards and other comparable mechanisms or institutional arrangements may have certain positive impacts.

100. At some moment in the future, it might be useful to look back at the situation of centrifugal chillers in Article 5 countries, to make an inventory of old and new chillers, and of all replacement activities carried out over the last decade, with and without financial support from dedicated funds. It is questionable whether this could be done through a questionnaire, because it will be difficult to identify the target group who should answer the survey. However, there should be a proper evaluation upon completion of projects to provide an overview of what has been achieved.

101. With HCFC phase-out approaching in Article 5 countries, the question arises whether replacements should be considered for HCFC-22 operated chiller equipment (equipment that is smaller in capacity than HCFC or HFC centrifugals), and in which manner this issue should be technically resolved. Without pointing at all kinds of concrete solutions at this stage, it can be mentioned that the equipment will and should be kept in operation for several years to come. Since technical solutions will be dealt with in non-Article 5 countries in the same manner, one may conclude that developments in both Article 5 and non-Article 5 countries should go in parallel, since similar issues will play a role in the near future.

102. Any HCFC-22 chiller phase-out should avoid the complexity of the perceived problem of CFC centrifugal chillers that need or needed replacement. As it is, the CFC centrifugal chiller issue acquired a life of its own in the Montreal Protocol arena, which did not contribute to further transparency. In a first instance, the best way possible seems to make HCFC-22 chillers an integral part of the HCFC phase-out process in a country, where the conversion of all types of equipment should be well described in the HPMP, while also setting clear targets.

103. Co-financing proved not to be very effective, specifically regarding the centrifugal chiller sector. It is expected that in future co-financing will occur for a wide range of activities. It seems unavoidable to investigate this co-financing through demonstration projects, for instance on ODS destruction. In such a case, the conditions for cooperation between implementing agencies and Article 5 countries should be precisely defined and critically evaluated on a regular basis.

104. Given the results from the different country projects for chiller replacement, one can conclude that in some cases, Article 5 country government initiatives and control helped to execute the programme while in other cases, government initiatives were even counterproductive. From the experience gained, no direct recommendations can be given for fully funded or co-funded operations such as CFC chiller replacements. It is expected that this may also hold true for other Multilateral Fund supported operations where co-funding should and could play an important role.

XII. Lessons learned

105. Centrifugal CFC-based chillers were typically replaced by centrifugal chillers using an alternative, although other technologies than centrifugal chillers might have been a better suited and therefore superior option. Implementing agencies or their technical experts should therefore thoroughly evaluate all technical options before choosing the replacement technology. Other options, such as screw chillers for example might in certain cases be more economical and ecological than same-technology replacements.

106. It was noted that implementing agencies, after having experienced delays and non co-operative attitudes from chiller owners, did not collect and forward information regarding the reasons for this

attitude. This would have provided both the agencies as well as the Multilateral Fund with important insights and would have helped in developing improved project methodologies.

107. The replacement of centrifugal CFC chillers has been successful to some degree. This was mainly due to the fact that in some Article 5 countries, service and supplier organizations, financial institutions and other entities were involved in helping to identify eligible equipment and to provide loans at low interest rates. It is however difficult to recommend any structure in this respect, since in some Article 5 countries such a framework was a real asset while in other Article 5 countries it did not seem to contribute to any real progress (e.g., the potential ESCO involvement in Brazil has not yet proven effective at all, given the fact that no results on implementation have been reported for several years).

108. A full account of experiences and lessons learned in this desk study as well as in the country case studies is presented in Annex V.

XIII. Recommendations

109. The Executive Committee may wish to:

(a) Take note of the desk study on the evaluation of chiller projects as presented in document UNEP/OzL.Pro/ExCom/58/9;

(b) Urge the bilateral and implementation agencies to accelerate implementation of the current chiller projects with co-funding modalities and to provide a progress report to the 59th Meeting of the Executive Committee, as requested by decision 47/26(f);

(c) Request the Senior Monitoring and Evaluation Officer to consider including a final evaluation of completed chiller projects in the evaluation work programme at some future date, possibly 2011, to provide an overview of what has been achieved;

(d) Encourage bilateral and implementing agencies to continue in their efforts to explore the applicability of carbon market instruments, such as the Clean Development Mechanism or the Voluntary Carbon Standard, for the replacement of HCFC equipment, particularly the chiller equipment;

(e) Suggest to the bilateral and implementing agencies that for any project they might undertake related to chiller conversion, a thorough analysis of the technical, economical, financial, co-funding and environmental issues associated with the replacement should be completed, and the economic viability and long term sustainability should be demonstrated prior to submitting a request for approval. Such projects, as per decision 47/26(g), would not be supported by the Multilateral Fund;

(f) Request the Senior Monitoring and Evaluation Officer to take action to disseminate the conclusions and lessons learned in the desk study on the evaluation of chiller projects to relevant countries and implementing agencies.

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Annex I

CHECKLIST OF EVALUATION QUESTIONS

Chiller project update

1. Does the country have an inventory/database of all CFC chillers?

2. How many chillers of the total were replaced to date and how many remain? What is the CFC phase-out achieved?

3. Which institution(s) coordinate(s) the chiller replacement (policies and funding)?

Management modality and legislation

1. What is the current and future (planned) management modality for the chiller phase-out (not just the project portion funded by the Multilateral Fund) (i.e. PMU, external consultant, NOU managed, etc.)?

2. Why was this management modality chosen and is it working well? If not, why?

3. Has a workable plan been designed and put in place for replacing all CFC chillers? Does it have a high probability of meeting the phase-out obligation schedule?

4. Were differences in approach needed and planned for the public and private sector chillers?

5. What was your country's choice for a chiller phase-out funding modality and why (i.e. revolving fund, grants and loans, etc.)?

6. Are the required regulatory provisions to enhance the CFC chiller phase-out in place? If not, what is still needed?

Project delays and implementation modalities

1. What were/are the reasons for implementation delays, barriers, impediments and plans for overcoming these? Were there unforeseen difficulties?

2. What were the implementation modalities and impacts (there have often been delays associated with co-financing requirements)?

3. What are the main reasons for public and private sector chiller operators to delay replacement?

4. To what extent and how have they been addressed and overcome?

5. Are chiller replacements occurring outside the project, i.e. chiller owners and operators are undertaking replacements on their own initiative? If so, why?

Co-funding and donor coordination

1. What were the final (actual) costs with a breakdown by equipment, installation, construction, energy efficiency and energy costs savings?

2. What were, or are, the potential co-funding sources explored and responses received?

3. What formal agreements are/were needed and concluded (why were they needed, with whom, and what is covered)?

4. What actual co-funding has been mobilized or is anticipated?

5. What were, or are, the problems associated with donor coordination in the face of different criteria, schedules and priorities?

Financing modalities

1. For the chillers that have been replaced to date, what were the actual chiller replacement costs (relative to expectations)?

2. Who paid what share?

3. What was the role (or possible future role) of energy savings in both project design and implementation?

4. What are the chiller owners' perceptions/views on the efficacy of the various funding arrangements or mechanisms (concessional loans, grants, revolving funds, etc.)?

5. How do NOUs see the role of carbon credits in facilitating replacements?

CFCs recovery and destruction

1. Were there any CFC recovered from the chiller project(s)?

2. Is there, or will there be, any monitoring of recovered CFCs?

3. Is there is a plan in place to deal with the recovered CFCs? (Re-use or destruction?)

Future activities

1. What is the plan for any remaining conversions?

2. Will declining CFC supplies result in replacing the remaining CFC chillers without Multilateral Fund grants?

3. Is a dual or tri-support system (Multilateral Fund, GEF and carbon financing) workable?

4. Are energy savings now a sufficient driver to cause replacements?

5. What are the lessons learned that may contribute to future policy development?

Annex II

CHILLER OVERVIEW OF APPROVED PROJECTS

Country	Code	Agency	Status*	Subsector	Project Title	ExCom Provision	ExCom Provision (Continued)	ODP To Be Phased Out	ODP Phased Out*	Date Approved	Approved Planned Date of Completion	Date Completed *	Planned Date of Completion for Ongoing Projects*	Funds Approved	Funds Returned	Funds Disbursed*
Chiller funding window: projects approved at the 47th Meeting or later																
Region: AFR	AFR/REF/48/ DEM/34	Germany	ONG	Chiller	Strategic demonstration project for accelerated conversion of CFC chillers in 5 African countries (Cameroon, Egypt, Namibia, Nigeria and Sudan)	Approved on the understanding that external resources of US $477,876 for the whole project were to be used only for activities considered to be part of the project costs; disbursement of the amounts approved would be dependent upon the availability of external resources as specified, to be confirmed by the Secretariat, based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources; additional countries in Africa could receive support for phase-out in the chiller sector under the project, provided that funding under the project was available, and that all other conditions established by the Executive Committee in its respective decisions regarding chiller demonstration projects were being met.	UNIDO and the bilateral agencies involved would inform the Secretariat on an annual basis, and in time for the last Meeting of the Executive Committee, in every year of project implementation as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0		Apr-06	Sep-09		Sep-09	192,500	0	93,739
Region: AFR	AFR/REF/48/ DEM/35	Japan	ONG	Chiller	Strategic demonstration project for accelerated conversion of CFC chillers in 5 African countries (Cameroon, Egypt, Namibia, Nigeria and Sudan)	Approved on the understanding that external resources of US $477,876 for the whole project were to be used only for activities considered to be part of the project costs; disbursement of the amounts approved would be dependent upon the availability of external resources as specified, to be confirmed by the Secretariat, based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources; additional countries in Africa could receive support for phase-out in the chiller sector under the project, provided that funding under the project was available, and that all other conditions established by the Executive Committee in its respective decisions regarding chiller demonstration projects were being met.	UNIDO and the bilateral agencies involved would inform the Secretariat on an annual basis, and in time for the last Meeting of the Executive Committee, in every year of project implementation as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0		Apr-06	Sep-09		Sep-09	700,000	0	
Region: AFR	AFR/REF/48/ DEM/36	France	ONG	Chiller	Strategic demonstration project for accelerated conversion of CFC chillers in 5 African countries (Cameroon, Egypt, Namibia, Nigeria and Sudan)	Approved on the understanding that external resources of US $477,876 for the whole project were to be used only for activities considered to be part of the project costs; disbursement of the amounts approved would be dependent upon the availability of external resources as specified, to be confirmed by the Secretariat, based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources; additional countries in Africa could receive support for phase-out in the chiller sector under the project, provided that funding under the project was available, and that all other conditions established by the Executive Committee in its respective decisions regarding chiller demonstration projects were being met.	UNIDO and the bilateral agencies involved would inform the Secretariat on an annual basis, and in time for the last Meeting of the Executive Committee, in every year of project implementation as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0		Apr-06	Sep-09		Sep-09	360,000	0	0

*According to the 2007 Progress Reports.
As of 3 July 2008

Annex II

CHILLER OVERVIEW OF APPROVED PROJECTS

Country	Code	Agency	Status*	Subsector	Project Title	ExCom Provision	ExCom Provision (Continued)	ODP To Be Phased Out	ODP Phased Out*	Date Approved	Approved Planned Date of Completion	Date Completed *	Planned Date of Completion for Ongoing Projects*	Funds Approved	Funds Returned	Funds Disbursed*
Region: AFR	AFR/REF/48/DEM/37	UNIDO	ONG	Chiller	Strategic demonstration project for accelerated conversion of CFC chillers in 5 African countries (Cameroon, Egypt, Namibia, Nigeria and Sudan)	Approved on the understanding that external resources of US $477,876 for the whole project were to be used only for activities considered to be part of the project costs; disbursement of the amounts approved would be dependent upon the availability of external resources as specified, to be confirmed by the Secretariat, based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources; additional countries in Africa could receive support for phase-out in the chiller sector under the project, provided that funding under the project was available, and that all other conditions established by the Executive Committee in its respective decisions regarding chiller demonstration projects were being met.	UNIDO and the bilateral agencies involved would inform the Secretariat on an annual basis, and in time for the last Meeting of the Executive Committee, in every year of project implementation as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0	0.0	Apr-06	Sep-09		Sep-09	747,500	0	26,521
Brazil	BRA/REF/47/DEM/275	UNDP	ONG	Chiller	Demonstration project for integrated management of the centrifugal chiller sub-sector, focusing on application of energy-efficient CFC-free technologies for replacement of CFC-based chillers	Approved funding, with external resources of US $252,000 to replace at least 12 chillers in the country (the external resources associated were to be used only for activities considered to be part of the project costs). Disbursement of the amounts approved was dependent upon the availability of external resources to be confirmed by the Secretariat based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources.	The agency was requested to inform the Secretariat on an annual basis, in time for the last Meeting of the Committee in every year of project implementation, as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0	0.0	Nov-05	Dec-08		Dec-09	1,000,000	0	0
Colombia	COL/REF/47/DEM/65	UNDP	ONG	Chiller	Demonstration project for integrated management of the centrifugal chiller sub-sector, focusing on application of energy-efficient CFC-free technologies for replacement of CFC-based chillers	Approved funding, with external resources of US $705,000 to replace at least 13 chillers in the country (the external resources associated were to be used only for activities considered to be part of the project costs). Disbursement of the amounts approved was dependent upon the availability of external resources to be confirmed by the Secretariat based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources.	The agency was requested to inform the Secretariat on an annual basis, in time for the last Meeting of the Committee in every year of project implementation, as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0	0.0	Nov-05	Dec-08		Jan-10	1,000,000	0	0

*According to the 2007 Progress Reports.
As of 3 July 2008

Annex II

CHILLER OVERVIEW OF APPROVED PROJECTS

Country	Code	Agency	Status*	Subsector	Project Title	ExCom Provision	ExCom Provision (Continued)	ODP To Be Phased Out	ODP Phased Out*	Date Approved	Approved Planned Date of Completion	Date Completed *	Planned Date of Completion for Ongoing Projects*	Funds Approved	Funds Returned	Funds Disbursed*
Cuba	CUB/REF/47/DEM/35	Canada	TRF	Chiller	Demonstration project for integrated management of the centrifugal chiller sub-sector, focusing on application of energy-efficient CFC-free technologies for replacement of CFC-based chillers	Approved funding, with external resources of US $410,125 to replace at least 7 chillers in the country and to convert a further 5 chillers (the external resources associated were to be used only for activities considered to be part of the project costs). Disbursement of the amounts approved was dependent upon the availability of external resources to be confirmed by the Secretariat based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources.	The agency was requested to inform the Secretariat on an annual basis, in time for the last Meeting of the Committee in every year of project implementation, as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed. Note: At its 51st Meeting, the Executive Committee noted that the project was trasnferred to UNDP.	0.0		Nov-05	Dec-08			196,871	-196,871	0
Cuba	CUB/REF/47/DEM/36	UNDP	ONG	Chiller	Demonstration project for integrated management of the centrifugal chiller sub-sector, focusing on application of energy-efficient CFC-free technologies for replacement of CFC-based chillers	Approved funding, with external resources of US $410,125 to replace at least 7 chillers in the country and to convert a further 5 chillers (the external resources associated were to be used only for activities considered to be part of the project costs). Disbursement of the amounts approved was dependent upon the availability of external resources to be confirmed by the Secretariat based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources.	The agency was requested to inform the Secretariat on an annual basis, in time for the last Meeting of the Committee in every year of project implementation, as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed. Note: At its 51st Meeting, the Executive Committee noted that the project was transferred from the Government of Canada to UNDP.	0.0	0.0	Nov-05	Dec-08		Mar-09	787,482	196,871	0
Region: EUR	EUR/REF/47/DEM/06	UNIDO	ONG	Chiller	Demonstration project on the replacement of CFC centrifugal chillers in Croatia, the former Yugoslav Republic of Macedonia, Montenegro, Romania, and Serbia	Approved funding, with external resources of US $416,175 to replace at least 12 chillers in the region (the external resources associated were to be used only for activities considered to be part of the project costs). Disbursement of the amounts approved was dependent upon the availability of external resources to be confirmed by the Secretariat based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources.	The agency was requested to inform the Secretariat on an annual basis, in time for the last Meeting of the Committee in every year of project implementation, as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0	0.0	Nov-05	Dec-08		Dec-08	1,069,074	0	114,627
Global	GLO/REF/47/DEM/268	IBRD	ONG	Chiller	Global chiller replacement project (China, India, Indonesia, Malaysia and Philippines)	Approved under the condition that implementation of the programme would include activities in China, India, Indonesia, Jordan, Malaysia, Philippines and Tunisia, with external resources of US $13,769,224 to replace at least 150 chillers (the external resources associated were to be used only for activities considered to be part of the project costs). Disbursement of the amounts approved was dependent upon the availability of external resources to be confirmed by the Secretariat based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources.	The agency was requested to inform the Secretariat on an annual basis, in time for the last Meeting of the Committee in every year of project implementation, as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0	0.0	Nov-05	Dec-13		Dec-13	6,884,612	0	0

*According to the 2007 Progress Reports.
As of 3 July 2008

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CHILLER OVERVIEW OF APPROVED PROJECTS

Country	Code	Agency	Status*	Subsector	Project Title	ExCom Provision	ExCom Provision (Continued)	ODP To Be Phased Out	ODP Phased Out*	Date Approved	Approved Planned Date of Completion	Date Completed *	Planned Date of Completion for Ongoing Projects*	Funds Approved	Funds Returned	Funds Disbursed*
Global	GLO/REF/48/TAS/275	UNEP	ONG	Chiller	Global technical assistance programme in the chiller sector			0.0	0.0	Apr-06	Apr-09		Apr-09	200,000	0	0
Region: LAC	LAC/REF/47/DEM/36	UNDP	ONG	Chiller	Demonstration project for integrated management of the centrifugal chiller sub-sector in the Caribbean, focusing on application of energy-efficient CFC-free technologies for replacement of CFC-based chillers	Approved funding, with external resources of US $690,000 to replace at least 14 chillers in the region (the external resources associated were to be used only for activities considered to be part of the project costs). Disbursement of the amounts approved was dependent upon the availability of external resources to be confirmed by the Secretariat based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources.	The agency was requested to inform the Secretariat on an annual basis, in time for the last Meeting of the Committee in every year of project implementation, as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0	0.0	Nov-05	Dec-08		Jun-09	1,000,000	0	0
Syrian Arab Republic	SYR/REF/47/DEM/93	UNIDO	ONG	Chiller	Demonstration project on the replacement of CFC centrifugal chillers	Approved funding, with external resources of US $27,195 to replace at least 3 chillers in the country and to convert a further 4 chillers (the external resources associated were to be used only for activities considered to be part of the project costs). Disbursement of the amounts approved was dependent upon the availability of external resources to be confirmed by the Secretariat based on the advice from the agency that external funding had been secured. The ratio between the maximum amount of the fund resources that could be disbursed and the external resources confirmed by the Secretariat should be equal to the ratio between the amount approved and the corresponding amount of associated external resources.	The agency was requested to inform the Secretariat on an annual basis, in time for the last Meeting of the Committee in every year of project implementation, as well as in the year of completion, on progress in terms of implementation, main experiences and additional external resources acquired for the chiller phase-out and major market transformations observed.	0.0	0.0	Nov-05	Dec-08		Dec-08	585,961	0	-107,309
Early chiller investment, technical assistance and training projects																
China	CPR/REF/06/TRA/05	UNDP	FIN	Training programme/ workshop	Establishment of a training programme for centrifugal chillers and domestic refrigeration service managers and technicians			0.0	0.0	Feb-92	Sep-93	Sep-93		75,000	0	75,000
India	IND/REF/10/INV/08	IBRD	FIN	Chiller	Substitution of CFC-11 refrigerant by HCFC-123 in centrifugal chillers (Blue Star)			36.0	36.0	Jun-93	Jun-96	Dec-97		567,000	-146,504	420,496
Côte d'Ivoire	IVC/REF/37/INV/17	France	TRF	Chiller	ODS phase out in 50 existing centrifugal chillers units	Approved on the understanding that the project, having a significant cost-share component and, being a demonstration project for the African region, would complete the cycle of demonstration projects in the chiller sub-sector for each region, and that no further chiller demonstration projects would be		18.0		Jul-02	Aug-06		Dec-07	1,000,000	0	0
Lebanon	LEB/REF/28/	France	COM	Technical	Remaining issues for a RMP			0.0		Jul-99	Feb-02	Aug-01		45,750	0	24,784
Lebanon	LEB/REF/28/TAS/31	Germany	FIN	Technical assistance/support	Remaining issues for a RMP and preparation of strategy and projects for reduction of CFC emissions in centrifugal chillers			0.0	0.0	Jul-99	Feb-02	Nov-01		37,550	-3	37,547
Malaysia	MAL/REF/18/TAS/77	IBRD	FIN	Recovery/recycling	Reduction of the consumption of ODSs in the commercial air conditioning sector via training, recovery and recycling of CFC-11 and CFC-12 in chillers at Mashrae			105.0	4.5	Nov-95	Nov-96	Nov-00		824,078	-118,061	706,017

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As of 3 July 2008

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CHILLER OVERVIEW OF APPROVED PROJECTS

Country	Code	Agency	Status*	Subsector	Project Title	ExCom Provision	ExCom Provision (Continued)	ODP To Be Phased Out	ODP Phased Out*	Date Approved	Approved Planned Date of Completion	Date Completed *	Planned Date of Completion for Ongoing Projects*	Funds Approved	Funds Returned	Funds Disbursed*
Mexico	MEX/REF/08/TRA/19	USA	FIN	Training programme/ workshop	Chiller hands-on training			0.0		Oct-92	Oct-93	Oct-93		340,000	0	340,000
Mexico	MEX/REF/13/TRA/25	USA	FIN	Training programme/ workshop	Cancun chiller workshop			0.0		Jul-94	Jul-95	Jul-95		9,000	0	9,000
Mexico	MEX/REF/28/INV/95	UK	FIN	Chiller	Chiller concessional lending pilot project	The Multilateral Fund money repaid in the first phase of the project would be made available for redeployment by the Executive Committee within three years of project approval and would be usable, based on a decision to be taken by the Executive Committee, either for a second phase of chiller purchases in Mexico or for other specific ODS phase-out projects in that country.		5.0	7.8	Jul-99	Feb-04	Mar-04		565,000	0	565,000
Syrian Arab Republic	SYR/REF/29/INV/56	France	COM	Chiller	CFC emission reduction in central air conditioning			0.9		Nov-99	Jun-02	Dec-06		143,000	0	106,383
Thailand	THA/REF/26/INV/104	IBRD	FIN	Chiller	Programme to reduce the usage of CFC-11 and CFC-12 in chiller servicing by replacing CFC-based chillers with HFC-134a and HCFC-123 chillers at Electricity Generating Authority (EGAT)	Approved on the understanding that the project did not constitute a precedent and that its approval was without prejudice to the ongoing discussions on the question of concessional lending. The World Bank was requested to provide an annual update on the status of the project and to draw lessons learned based on the following information: (i) whether actual savings were equal or greater than originally anticipated; and (ii) whether CFCs from old chillers were properly recovered, recycled and reused in servicing remaining chillers.		13.2	13.2	Nov-98	Dec-02	Sep-03		2,475,000	-1,276,053	0
Venezuela (Bolivarian Republic of)	VEN/REF/08/INV/08	IBRD	CLO	Chiller	Replacement of CFC by HFC-134a as a refrigerant in central air conditioning units at Instituto Venezolano de los Seguros Sociales			0.0	0.0	Oct-92	Apr-94			851,000	-851,000	0
Venezuela (Bolivarian Republic of)	VEN/REF/08/INV/09	IBRD	FIN	Chiller	Replacement of CFC by HFC-134a as a refrigerant in central air conditioning units at Clínica Atlas, Hospitalización y Servicios			4.0	4.0	Oct-92	Apr-94	Jan-97		115,000	0	115,000
Venezuela (Bolivarian Republic of)	VEN/REF/08/INV/10	IBRD	FIN	Chiller	Replacement of CFC by HFC-134a as a refrigerant in central air conditioning units at Instituto de Prevencion Social del Médico			2.0	2.0	Oct-92	Apr-94	Sep-95		69,000	0	69,000
Venezuela (Bolivarian Republic of)	VEN/REF/08/INV/11	IBRD	CLO	Chiller	Replacement of CFC by HFC-134a as a refrigerant in central air conditioning units at Congreso de la Republica			0.0	0.0	Oct-92	Apr-94			65,000	-65,000	0
Viet Nam	VIE/REF/28/INV/22	France	FIN	Chiller	CFC emission reductions in spinning halls air conditioning systems chillers (pilot project)			3.6	3.6	Jul-99	Aug-01	Dec-02		197,340	0	197,340

*According to the 2007 Progress Reports.
As of 3 July 2008

Annex III

SUMMARY OF CHILLER PROJECTS AS COMPONENTS OF NPPs AND TPMPs

Country (project no.)	Agency	Date approved	Project title	Project description for the chiller component	Executive Committee provisions
Argentina (ARG/PHA/ 47/INV/148)	IBRD	Nov-05	National CFC phase-out plan: 2006 work programme	Implementation of several activities to reduce the use of CFC refrigerants in chillers. The World Bank was not foreseen as a cooperating implementing agency in the original agreement between the Government and the Executive Committee. With the reallocation of funds within the plan to accommodate a chiller component with the World Bank as its implementer, the agreement has been revised.	Approved the revised agreement between the Government and the Executive Committee including the World Bank as a cooperating implementing agency for a chiller component, as proposed by the Government.
Bahrain (BAH/PHA/ 50/INV/16)	UNDP Jointly impleme nted with UNEP.	Nov-06	Terminal phase-out management plan (first tranche)	Technical assistance project for chiller retrofit/replacement	
Brazil (BRA/PHA/ 47/INV/274)	UNDP	Nov-05	National CFC phase-out plan: fourth tranche	The activities proposed are related to the implementation of activities in the commercial refrigeration and chillers sub-sectors.	
Brazil (BRA/PHA/ 56/INV/284)	UNDP	Nov-08	National CFC phase-out plan (seventh tranche)	Five (5) recovery machines for the chiller sector	
Colombia (COL/PHA/ 41/INV/60)	UNDP	Dec-03	National phase-out plan for Annex A (Group I and II) substances: first implementation programme	An incentive to equipment owners to replace or retrofit the CFC-based chillers with new non-CFC refrigerant.	
Cuba (CUB/PHA/ 48/INV/37)	UNDP	Apr-06		To complete the implementation of the following activities: chiller containment and engineering; incentive programme for retrofit chillers and consoles.	Upon a request by the Government of Cuba, funds transferred from the balance of the two previous tranches approved for the Governments of France and Germany.
Ecuador (ECU/PHA/ 45/INV/36)	IBRD	Apr-05	National CFC phase-out plan: 2005 annual programme	Training in the chillers servicing sector	
Ecuador (ECU/PHA/ 49/INV/37)	IBRD	Jul-06	National CFC phase-out plan: 2006 annual programme	Preparation and implementation of a chiller replacement project; training in the chillers servicing sector	
Ecuador (ECU/PHA/ 52/INV/39)	IBRD	Jul-07	National CFC phase-out plan: 2007 annual programme	Implementation of a chiller replacement project	
Ecuador (ECU/PHA/ 56/INV/41)	IBRD	Nov-08	National CFC phase-out plan: 2008 annual programme	Implementation of chiller replacement and a training course on chiller maintenance and best practices conducted	Approved on the understanding that the World Bank would forward a copy of the report on the chiller replacement to the Secretariat when it became available.
Honduras (HON/PHA/ 55/INV/26)	UNIDO	Jul-08	Terminal phase-out management plan (first tranche)	Implementation of an incentive programme for conversion of domestic and industrial refrigeration systems and chillers	

Country (project no.)	Agency	Date approved	Project title	Project description for the chiller component	Executive Committee provisions
Jamaica (JAM/PHA/ 37/TAS/16)	Canada	Jul-02	Terminal phase-out management plan for CFCs: training and recovery and recycling	Additional recovery and recycling equipment and associated training for the commercial/industrial, MAC and chillers sub-sectors	
Malaysia (MAL/PHA/ 35/INV/145)	IBRD	Dec-01	National CFC phase-out plan: 2002 annual programme	Retirement of existing CFC-dependent equipment, including chillers and vehicles	
Malaysia (MAL/PHA/ 52/INV/158)	IBRD	Jul-07	National CFC phase-out plan: 2007 annual programme	Continue with the chiller replacement/retirement programme.	The World Bank and the Government were encouraged to examine closely the need for stockpiling and the functioning of the recovery and recycling programme to plan for the continued demand for CFCs beyond 2010, in view of the approaching final phase-out.
Mauritius (MAR/PHA/ 50/INV/18)	Germany	Nov-06	Implementation of an ODS terminal phase-out management plan (third tranche)	Finish retrofitting the chiller at New Court House.	
Mexico (MEX/PHA/ 45/INV/124)	IBRD	Apr-05	National CFC phase-out plan: 2005 work programme	For the second phase, five chiller owners have already been identified, and discussions are ongoing with several more. The World Bank was originally not mentioned in the agreement between the Government and the Executive Committee (at its 41st Meeting, the Committee endorsed the implementation of this activity that would be subsumed into the phase-out plan).	
Mexico (MEX/PHA/ 50/INV/130)	UNIDO	Nov-06	National CFC phase-out plan: 2006 work programme	Four (4) chiller replacements; continue the development of a strategy for the long-term management of refrigerants, which focuses on storage, recycling, and the feasibility of installing a destruction facility.	
Mongolia (MON/PHA/ 47/INV/10)	Japan	Nov-05	Terminal phase-out management plan: first tranche	Establishment of CFC stockpiles for servicing the two chillers in operation after 2010 (about 1.5 ODP tonnes of CFC-11) and other CFC-based refrigeration systems.	
Thailand (THA/PHA/ 35/INV/137)	IBRD	Dec-01	National CFC phase-out plan: 2002 Annual Programme	Retirement of existing CFC-dependent equipment, including chillers and vehicles	
Turkey (TUR/PHA/ 35/INV/75)	IBRD	Dec-01	Total phase-out of CFCs plan: 2001 and 2002 annual programmes	The chiller replacement program will be started in the second half of 2002 by inviting owners of chillers to register their chillers so that a database can be established. The information will assist the development of the more detailed plan for the chiller replacement programme, including selection criteria, standard contract form.	
Turkey (TUR/PHA/ 41/INV/81)	IBRD	Dec-03	Total phase-out of CFCs plan: 2004 annual programme	Sign contracts with eligible chiller companies as identified during 2003 and 2004.	

Country (project no.)	Agency	Date approved	Project title	Project description for the chiller component	Executive Committee provisions
Turkey (TUR/PHA/ 44/INV/85)	IBRD	Dec-04	Total phase-out of CFCs plan: 2005 annual programme	Sign contracts with eligible chiller companies as identified during 2004 and 2005.	
Turkey (TUR/PHA/ 47/INV/87)	IBRD	Nov-05	Total phase-out of CFCs plan: 2006 annual programme	Sign contracts with eligible chiller companies as identified since 2003.	
Turkey (TUR/PHA/ 50/INV/89)	IBRD	Nov-06	Total phase-out of CFCs plan: 2007 annual programme	Signature of contracts with eligible chiller companies as identified since 2003	

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Annex IV

REASONS FOR IMPLEMENTATION DELAYS

1. The reasons for implementation delays are the following:

   (a) The East Asia financial crisis of 1998 to 2001 had significant impacts on the Thailand project. Thailand introduced restrictions or prohibitions for commercial banks to provide loans to any enterprise with any amount outstanding under a non-performing loan and the interest rates available on the market became unattractive;

   (b) Lack of a policy driver for ensuring a transition to new chillers, from either the ODS or energy efficiency perspective. No legislation and/or regulations were in place requiring that CFC chillers be replaced or facilitating replacement by non-CFC chillers;

   (c) In the case of Thailand, the Ministry of Energy offered several financial subsidy schemes to promote energy efficiency targeted, *inter alia*, at replacing old CFC chillers with new energy efficient non-CFC chillers. These incentives were considered by the private sector more attractive than the ones offered by the Multilateral Fund project; the interest rates were very low with longer repayment period and no requirements to dismantle the old CFC chiller and to install a data logger to the new chiller. Buying and installing data loggers, reporting, destruction of old chillers, the chiller manufacturer reports, adds around 15 per cent to the project costs;

   (d) Difficulties were experienced in creating/activating/raising the excise tax as a disincentive to continued CFC use;

   (e) Borrowers dropping out of the project;

   (f) Reluctance of suppliers to participate in a programme with a complex set of requirements, namely, performance guarantees, detailed proposal submissions and bank guarantees;

   (g) Lack of flexibility in project design;

   (h) Submission of individual project documents for owners of multiple chillers;

   (i) Complex project guarantee requirements. In Thailand this explains why several project owners chose to undertake additional chiller conversions without using the project window;

   (j) No technical assistance budget available although needed;

   (k) Special Drawing Rights (SDRs) currency problems. SDRs are potential claims on the freely usable currencies of International Monetary Fund members. SDRs are defined in terms of a basket of major currencies used in international trade and finance. At the first stage, the source of funds (GEF) would support a grant in term of SDR currency, which caused problems because it was difficult to identify the exact amount of the loan. However, this problem was solved by fixing the exchange rate at SDR1 = US $1.27645;

   (l) Delays in negotiating the default clause;

   (m) New guidelines and regulations for implementing agencies were required for individual loan schemes (for example, the World Bank) as former guidelines were not applicable;

(n) The project's limited timeframe made it difficult to find new clients;

(o) Lack of confidence in new chiller technologies;

(p) Unclear direction on how to scrap and/or dismantle existing chillers;

(q) Participants doubtful due to previous unsuccessful experiences with a similar programme;

(r) Chiller replacement was considered by some as a second priority. Hotels would invest first in convenient facilities, room decoration and renovation. It was reportedly difficult to persuade enterprises in this sector to join the programme;

(s) Many enterprises expressed reluctance to invest as long as CFCs were still available, therefore restrictions on CFC supply are required;

(t) Implementation delays due to an unstable political environment and problems with inter-governmental relations (Côte d'Ivoire);

(u) Lack of inter-institutional agreements (for example, Mexico);

(v) Delays associated with building modifications required to accommodate the replacement chillers;

(w) Delays associated with the inadequate assignment of human resources for the chiller projects.

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Annex V

LESSONS LEARNED FROM THE CHILLER PROJECT DOCUMENTS AND THE THREE CASE STUDIES

I. Lessons learned from the document review

(a) Mechanisms and methodologies

1. Different methodologies/replacement schemes, with a high degree of flexibility, are necessary to adapt a programme to the needs in different countries where markedly different local conditions prevail.

2. Support for the replacement of existing chillers, short of funding full replacement, can be provided in a number of different ways such as rebates, loans to the owner or performance contracting where the technology provider guarantees energy efficiency.

3. National policies regarding the final phase-out of CFCs are not just awareness raising and a needed stimulus, but likely a precondition for a large number of centrifugal chiller owners to pursue replacement projects.

4. A key lesson learned in Thailand was that when field testing a new or innovative mechanism such as this project entailed, flexibility (time allocation) needs to be build into the project to take account of unforeseen barriers and impediments.

(b) Financing

5. Demonstration projects have shown that replacement of CFC chillers can successfully be funded with grants combined with loans but their overall efficacy in facilitating replication remains questionable.

6. The amount of financial support required for chiller replacement varies depending on the prevailing national conditions such as tariffs, regulations, energy costs, etc..

7. The use of two funding sources, the Multilateral Fund and the Global Environment Facility (GEF), can complicate project implementation. For example, in the Thailand project, the financial intermediaries (FI) and enterprises had to report separately on their utilization of the two funds, and the World Bank task team had to manage two budgets and report completion twice. From the Bank and the country perspectives, similar learning objectives could have been incorporated into a simpler instrument, possibly even by a technical assistance project. Efforts need to be made to merge reporting requirements.

(c) Recovery and recycling of CFCs

8. If a non-governmental organization (NGO) is utilized to implement a CFC recovery and recycle programme, it will need to prepare a business plan to maintain the facility and provide the service continuously. It will also need an assurance of continuing financial support. Any lack of response from the owners of chillers and other stakeholders will make it difficult for voluntary societies or NGOs to implement the business plan effectively. According to the information available, recovery and recycling for chillers is so far economically not sustainable. However, with rising CFC prices and rapidly declining supplies of virgin CFC this might change.

9. The success of a refrigerant recovery and recycling network depends on close cooperation between the network operator and the government authority, which enforces the relevant regulations requiring the CFC users to recover and recycle their refrigerants.

10. The nature of the recovery and recycling network facility, if using a highly sophisticated technology and electronic controls, requires a dedicated team to maintain and operate the equipment on a full time basis.

(d) Lessons learned from the Mexican chiller project

11. As per an implementing agency, the main lesson learned from the Mexican chiller project was that it is feasible to design a revolving fund that is sustainable over time and that can help speed the replacement of chillers. Other lessons learned were:

(a) The revolving fund design is easy to implement and can be easily replicated in other countries. This mechanism can be used to efficiently replace a significant number of chillers with a relatively small budget;

(b) Reliable procedures developed to measure and verify electricity savings are essential to guarantee that chiller producers offer the best products and stand behind them. This is especially important if energy savings are to be used to generate Certified Emission Reductions (CERs) with a view to carbon financing;

(c) Loan conditions, both in units of investment (i.e., an inflation-adjusted monetary unit updated daily based on the consumer price index) and the US dollar, were attractive to building owners, proving that a credit programme in the sector is feasible;

(d) CFC losses (leaks) may be much higher than anticipated. In one extreme case, in Mexico, the old chiller was supposed to contain 240 kg of CFC-11, but only 40 kg were recovered.

(e) Private sector response and economic framework

12. Effective communication is required to dispel an often high degree of initial scepticism of chiller owners, particularly during the start-up phase. Experience has shown (for example, Thailand) that once the benefits of chiller replacement become clear, the scepticism disappears. Demonstration projects thus play an important role.

13. One driving factor for chiller replacement is the increasing realization of the future declining availability of CFC supply.

14. There is significant interest from the chiller manufacturers who wish to market their replacement products. Their marketing efforts can include activities such as identifying chiller owners, awareness raising, assessing the owners' needs for replacement, and their interest, and offering other forms of support. Manufacturers of centrifugal chillers have excellent avenues for communicating with chiller owners.

15. As per the implementing agency, the Thailand project was technically well conceived, but overestimated the willingness of the participants to come forward in spite of the low interest rate that was meant to attract them. The financial attraction of the offer was also eroded by the rapidly falling interest rates since the end of 2001. Other factors included rapidly changing economic conditions such as interest rate earnings and CER prices.

16. As per the PCR document THA.REF.26.INV.104, it was noted by the financial intermediary that more time was needed to identify and appraise the enterprises. In spite of the success of the project, the formalities and requirements of the programme discouraged additional participation by enterprises. If the

programme had been made more flexible and designed with a different approach of investment (i.e., financing) results could have perhaps been better.

17. As per an implementing agency report for the Thailand chiller project, projects of this nature being implemented in a very dynamic macroeconomic environment (for example, economic recovery, falling interest rates and increase in private savings) should have a flexible design to adjust to this environment. In addition, the Thailand project needed to remain competitive in the existing policy framework, even during implementation.

18. The Government of Thailand supported simultaneously competing initiatives (energy saving programmes and the chiller project) both focused on chillers and providing financing and other programmatic requirements on markedly differing terms. This was problematic.

II. Lessons learned from the three case studies

19. From Turkey's experience it was learned that it is difficult to convince chiller owners to convert their chillers if there is a need for a very high initial investment combined with a lack of incentives for energy efficiency (if low electricity tariffs and lack of other fiscal incentives for adopting energy saving devices prevail). To overcome these problems a high proportion of funding needed to be subsidized (Turkey offered 75 per cent as an interest-free loan and 25 per cent as a grant).

20. Detailed and separate case study reports have been prepared for Turkey (Chiller Revolving Fund) and the chiller demonstration projects for Croatia and the former Yugoslav Republic of Macedonia (both are part of the UNIDO-assisted demonstration project with the aim of replacing 12 CFC-based centrifugal chillers in five countries in the Eastern Europe and Central Asia Network with new energy efficient ones. This UNIDO project was designed to facilitate the early replacement of CFC chillers with low-energy efficiency to non-CFC chillers with a high-energy efficiency. These case study reports set out in each case the relevant background, the contextual setting, the project experience, the project specific evaluation conclusions and lessons learned. These are available from the Secretariat upon request.

21. Demonstration projects are often designed to give local commercial banks, suppliers and project promoters more comfort and flexibility in implementing and financing such projects on a stand-alone basis. They are usually often designed to address concerns and uncertainties related to new technology and the associated economics. However, with regard to large centrifugal chillers, there is only one viable refrigerant alternative at this time which is HFC-134a. Replacement technologies are also well known as there are only three significant suppliers (McQuay, Trane and Carrier) and these also are well known as is the associated economics. The projects in Croatia and the former Yugoslav Republic of Macedonia were thus more of a "kick-start" than a demonstration project and the "value added" aspects are open to question. This modality needs to be given close policy review in the context of future application in relation to the HCFC phase-out.

22. Demonstration projects such as those conducted in Croatia and the former Yugoslav Republic of Macedonia may not offer the best financing modality for future HCFC phase-out/replacement projects as such an approach as evidenced in these countries presented difficulty in selecting fairly a very limited number of beneficiaries (four in Croatia and two in the former Yugoslav Republic of Macedonia). In these cases financial support was often offered where it was often not really needed and tended to ignore those in most need because of credit worthiness, knowledgeable staff, etc. Furthermore, there was no evidence to suggest that this modality enhances the potential for replication except in the enterprises or entities receiving a grant.

23. It appears from the case studies in Croatia and the former Yugoslav Republic of Macedonia that energy savings are/were not a sufficient driver for chiller replacement. The key drivers noted were repair

costs and declining availability of CFCs and the 100 per cent funding of equipment cost through the Multilateral Fund was just an added bonus.

24. A key aspect of the Executive Committee's decision to fund chiller projects was to establish the extent to which projects have a built-in potential for replication in the absence of additional resources from the Multilateral Fund. In the case of the former Yugoslav Republic of Macedonia, the potential for replication seems to have been limited to, at a maximum, to any additional chillers owned by the beneficiaries.

25. The selection of beneficiaries for the demonstration projects in Croatia and the former Yugoslav Republic of Macedonia were reportedly made in concert with the Ozone Units. However, given the generality of the beneficiary selection criteria, it is not easy to see why the selected beneficiaries were picked. Major considerations were likely ease of implementation and low transaction costs. There may therefore be a need for the Multilateral Fund to direct more of its support to those beneficiaries where the support will make a critical difference and address the credit risks associated with those enterprises which cannot afford replacement. Perhaps the concept of "additionality" as per CDM requirements would be a good idea to include or at least take into consideration in establishing beneficiary selection criteria.

26. With the demonstration project funding approach utilized in Croatia and the former Yugoslav Republic of Macedonia where the Multilateral Fund pays for the equipment and the beneficiaries pays the collateral expenses such as building changes etc., the potential for additional chiller replacements appears to depend on the will of the chiller owners themselves. Based on the experience in Croatia and the former Yugoslav Republic of Macedonia, where there is more than one piece of equipment to be replaced at an enterprise and the associated building renovation costs are high, it is the view of the beneficiaries that it would have been better to replace both or all at the same time.

27. The regulatory frameworks established in Turkey appear to have been the primary driver and success factor for successfully phasing out early consumption of CFCs. A comprehensive legal regime with supply-side controls, set in place in a timely manner is thus essential to an effective and efficient phase-out but not enough. There is no plan in place as yet in Turkey to phase out the remaining chillers, many of which are suspected to be in hospitals and other critical locations. A comprehensive strategic plan with the full engagement of all stakeholders and especially the Government is necessary for the success of phase-out sub-projects.

28. An impact analysis, if prepared in advance, can assist in improving the priorities for beneficiary selection and at the same time minimize economic disruption. Croatia banned the import of CFCs early but without any consideration of, or economic analysis of, the impacted enterprises.

29. Tax exemptions can serve as an incentive when expenditures are incurred to meet international treaty obligations. Countries should be encouraged to include such legislative measures as part of their upcoming HPMPs.

30. Uncertainty exists currently with regard to the destruction of waste ODS especially CFCs. Some may be needed for equipment still in use since the equipment suppliers will need time to fill orders beginning 1 January 2010. Also, from a country economic perspective where the largest deterrent is the unavailability of funds, rather than consider destruction of unwanted CFCs through Multilateral Fund support alone, there is also the possibility that these wastes may qualify for cost support (destruction) under the various carbon credit financing schemes. Also, it may be wise to keep these in storage as they may be needed for bridging time delays that may be encountered with chiller replacement equipment deliveries and building modifications.

31. A revolving fund modality was considered for Croatia and the former Yugoslav Republic of Macedonia and whereas these are, or can be, a very useful financial mechanism as in the case of Turkey,

they can only be deployed if implemented early enough to allow for two-three payment/re-issue cycles. This was not possible in Croatia or the former Yugoslav Republic of Macedonia. The lesson learned is that if this is to be considered in the context of HPMPs then an early start will be necessary.

32. The revolving fund in Turkey was an innovative modality that has been demonstrated to be viable. Nonetheless, greater attention was needed regarding strategic planning to ensure that such mechanisms are identified as just a part of a needed comprehensive strategy or implementation plan to facilitate the phase-out of all chillers in both the private and public sectors. This was not the case. The lesson learned is that whereas a revolving fund can be a very useful funding mechanism, it must be viewed as just one component of a more comprehensive plan to address all of the targeted components. Whereas the revolving fund was very successful in Turkey for the participants, there is no plan in place to deal with the non-participants such as hospitals.

33. In the case of Turkey, it is not certain how the public sector chillers, especially those in the 400-600 hospitals in Turkey can or will be replaced when there are no more CFCs to maintain these chillers. Based on the experience in Turkey, it was reported that a revolving fund mechanism may not have effective and efficient application to public sector conversions or replacements unless procurement and other bureaucratic procedures can be streamlined.

34. When contemplating the need for different approaches for the private and public sector, the former Yugoslav Republic of Macedonia offers an interesting situation. All factories in the country were formerly state-owned enterprises. Some have now been sold in whole or part to the private sector. Where state partial ownership is retained, it is difficult to distinguish what is public or private. This can best be characterized as a private-public partnership enterprise with its own unique set of constraints. The lesson is that flexibility is required to accommodate such situations.

35. Careful consideration needs to be given to the terms of reference (TORs) for NGO assigned project agents. In the case of Turkey, the performance indicator (PI) for the Technology Development Foundation of Turkey (TTGV) (the NGO chiller revolving fund manager and project agent) ought not to have been solely the disbursement of funds as was reported. One PI could have been creating the "kick-start" or catalytic effect (including awareness) needed to create the needed country-wide momentum for replacements. The lesson is that ministry oversight on an ongoing basis is needed.

36. Revolving fund mechanisms in future could include as a target at least some of those in most need (where participation in the fund is necessary to enable the replacement). This means less emphasis to be given to wealthy beneficiaries with their likely enhanced credit worthiness, knowledgeable and trained staff and thus lower transaction costs who indicate they will convert regardless. This could be achieved by including or at least considering a clause in the selection criteria for beneficiaries relating to "additionality".

37. Large financial incentives may be required in some cases but not for all and perhaps not when energy saving are likely to relate to payback periods of less than five years which was the case for some in the former Yugoslav Republic of Macedonia and Turkey.

38. Special attention needs to be given to awareness raising and should be constantly reviewed if difficulty is encountered in identifying those that need most assistance from the Multilateral Fund. It appears, especially in the case of Turkey, that the only outreach appears to have been through awareness created by the chiller suppliers in their efforts to sell replacement equipment. There was no evidence to indicate that the implementing entity (TTGV) had in place any active programme to enhance participation relying largely on the suppliers to create business. This was an implementation shortfall.

39. Multi-stakeholder engagement from the onset is necessary for both problem ownership and sustainability of results and to ensure the creation of a level playing field.

40. Although there are numerous efforts being made to facilitate tripartite funding (GEF/MLF/carbon funding), and this will likely be a reality in future, based on discussions in the case study countries this arrangements remains impractical at this time due the longer processing time for project approval and the need for counterpart funding and mainly to the short compliance times dictated by the Montreal Protocol.

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